

## Low Noise, High Performance, Quad Operational Amplifier

July 1994

### 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. .  $6\text{nV}/\sqrt{\text{Hz}}$  (Max)  
 $4.3\text{nV}/\sqrt{\text{Hz}}$  (Typ)
- Slew Rate .....  $1\text{V}/\mu\text{s}$  (Min)  
 $3\text{V}/\mu\text{s}$  (Typ)
- Unity Gain Bandwidth .....  $8\text{MHz}$  (Typ)
- High Open Loop Gain (Full Temp) .....  $100\text{kV}/\text{V}$  (Min)  
 $250\text{kV}/\text{V}$  (Typ)
- High CMRR, PSRR (Full Temp).....  $86\text{dB}$  (Min)  
 $100\text{dB}$  (Typ)
- Low Offset Voltage Drift .....  $3\mu\text{V}/^\circ\text{C}$  (Typ)
- No Crossover Distortion
- Standard Quad Pinout

### Applications

- High Q Active Filters
- Audio Amplifiers
- Integrators
- Signal Generators
- Instrumentation Amplifiers

### Description

Low noise and high performance are key words describing the unity gain stable HA-5104/883. This general purpose quad amplifier offers an array of dynamic specifications including  $1\text{V}/\mu\text{s}$  slew rate (min), and  $8\text{MHz}$  bandwidth (typ). Complementing these outstanding parameters are very low noise specifications of  $4.3\text{nV}/\sqrt{\text{Hz}}$  at  $1\text{kHz}$  (typ) or  $6\text{nV}/\sqrt{\text{Hz}}$  (max).

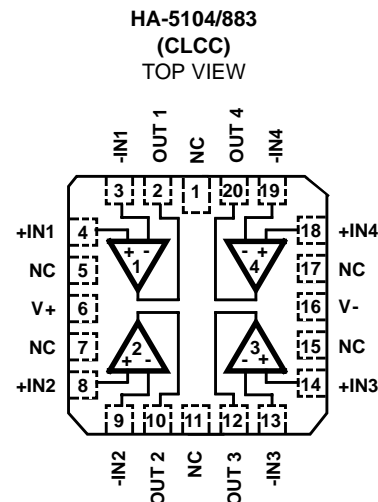
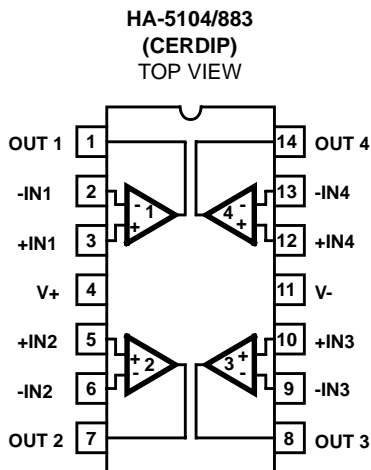
Fabricated using the Intersil standard high frequency D.I. process, these operational amplifiers also offer excellent input specifications such as  $2.5\text{mV}$  (max) offset voltage and  $75\text{nA}$  (max) offset current. Complementing these specifications are  $100\text{dB}$  (min) open loop gain and  $55\text{dB}$  channel separation (min). Economically, the HA-5104/883 also consumes a very moderate amount of power ( $225\text{mW}$  per package) while also saving board space and cost.

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.

### Ordering Information

PART NUMBER	TEMPERATURE RANGE	PACKAGE
HA1-5104/883	$-55^\circ\text{C}$ to $+125^\circ\text{C}$	14 Lead CerDIP
HA4-5104/883	$-55^\circ\text{C}$ to $+125^\circ\text{C}$	20 Lead Ceramic LCC

### Pinouts



# Specifications HA5104/883

## 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 <sub>J</sub> ) . . . . .	+175°C
Storage Temperature Range . . . . .	-65°C to +150°C
ESD Rating . . . . .	<2000V
Lead Temperature (Soldering 10s) . . . . .	+300°C

## Thermal Information

Thermal Resistance	$\theta_{JA}$	$\theta_{JC}$
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 <sub>J</sub> ≤ +175°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	$V_{INCM} \leq 1/2 (V+ - V-)$
Operating Supply Voltage . . . . .	±5V to ±15V	$R_L \geq 2k\Omega$

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: V<sub>SUPPLY</sub> = ±15V, R<sub>SOURCE</sub> = 100Ω, R<sub>LOAD</sub> = 500kΩ, V<sub>OUT</sub> = 0V, Unless Otherwise Specified.

PARAMETERS	SYMBOL	CONDITIONS	GROUP A SUBGROUPS	TEMPERATURE	LIMITS		UNITS
					MIN	MAX	
Input Offset Voltage	V <sub>IO</sub>	V <sub>CM</sub> = 0V	1	+25°C	-2.5	2.5	mV
			2, 3	+125°C, -55°C	-3.0	3.0	mV
Input Bias Current	+I <sub>B</sub>	V <sub>CM</sub> = 0V, +R <sub>S</sub> = 10kΩ, -R <sub>S</sub> = 100kΩ	1	+25°C	-200	200	nA
			2, 3	+125°C, -55°C	-325	325	nA
	-I <sub>B</sub>	V <sub>CM</sub> = 0V, +R <sub>S</sub> = 100kΩ, -R <sub>S</sub> = 10kΩ	1	+25°C	-200	200	nA
			2, 3	+125°C, -55°C	-325	325	nA
Input Offset Current	I <sub>IO</sub>	V <sub>CM</sub> = 0V, +R <sub>S</sub> = 10kΩ, -R <sub>S</sub> = 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 <sub>VOL</sub>	V <sub>OUT</sub> = 0V and +10V, R <sub>L</sub> = 2kΩ	4	+25°C	100	-	kV/V
			5, 6	+125°C, -55°C	100	-	kV/V
	-A <sub>VOL</sub>	V <sub>OUT</sub> = 0V and -10V, R <sub>L</sub> = 2kΩ	4	+25°C	100	-	kV/V
			5, 6	+125°C, -55°C	100	-	kV/V
Common Mode Rejection Ratio	+CMRR	ΔV <sub>CM</sub> = +5V, V+ = +10V, V- = -20V, V <sub>OUT</sub> = -5V	1	+25°C	86	-	dB
			2, 3	+125°C, -55°C	86	-	dB
	-CMRR	ΔV <sub>CM</sub> = -5V, V+ = +20V, V- = -10V, V <sub>OUT</sub> = +5V	1	+25°C	86	-	dB
			2, 3	+125°C, -55°C	86	-	dB

## Specifications HA5104/883

**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 <sub>OUT1</sub>	R <sub>L</sub> = 2k $\Omega$	1	+25°C	10	-	V
			2, 3	+125°C, -55°C	10	-	V
	-V <sub>OUT1</sub>	R <sub>L</sub> = 2k $\Omega$	1	+25°C	-	-10	V
			2, 3	+125°C, -55°C	-	-10	V
	+V <sub>OUT2</sub>	R <sub>L</sub> = 10k $\Omega$	1	+25°C	12	-	V
			2, 3	+125°C, -55°C	12	-	V
-V <sub>OUT2</sub>	R <sub>L</sub> = 10k $\Omega$	1	+25°C	-	-12	V	
		2, 3	+125°C, -55°C	-	-12	V	
Output Current	+I <sub>OUT</sub>	V <sub>OUT</sub> = -5V	1	+25°C	10	-	mA
			2, 3	+125°C, -55°C	10	-	mA
	-I <sub>OUT</sub>	V <sub>OUT</sub> = +5V	1	+25°C	-	-10	mA
			2, 3	+125°C, -55°C	-	-10	mA
Quiescent Power Supply Current	+I <sub>CC</sub>	V <sub>OUT</sub> = 0V, I <sub>OUT</sub> = 0mA	1	+25°C	-	6.5	mA
			2, 3	+125°C, -55°C	-	7.5	mA
	-I <sub>CC</sub>	V <sub>OUT</sub> = 0V, I <sub>OUT</sub> = 0mA	1	+25°C	-6.5	-	mA
			2, 3	+125°C, -55°C	-7.5	-	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**

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 <sub>OUT</sub> = -3V to +3V	4	+25°C	1	-	V/ $\mu$ s
	-SR	V <sub>OUT</sub> = +3V to -3V	4	+25°C	1	-	V/ $\mu$ s
Rise and Fall Time	T <sub>R</sub>	V <sub>OUT</sub> = 0 to +200mV 10% $\leq$ T <sub>R</sub> $\leq$ 90%	4	+25°C	-	200	ns
	T <sub>F</sub>	V <sub>OUT</sub> = 0 to -200mV 10% $\leq$ T <sub>F</sub> $\leq$ 90%	4	+25°C	-	200	ns
Overshoot	+OS	V <sub>OUT</sub> = 0 to +200mV	4	+25°C	-	35	%
	-OS	V <sub>OUT</sub> = 0 to -200mV	4	+25°C	-	35	%

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**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Characterized at:  $V_{SUPPLY} = \pm 15V$ ,  $R_{LOAD} = 2k\Omega$ ,  $C_{LOAD} = 50pF$ ,  $A_{VCL} = 1V/V$ , 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 $\Omega$
Input Noise Voltage Density	$E_N$	$R_S = 20\Omega$ , $f_O = 1000Hz$	1	+25°C	-	6	nV/ $\sqrt{Hz}$
Input Noise Current Density	$I_N$	$R_S = 2M\Omega$ , $f_O = 1000Hz$	1	+25°C	-	3	pA/ $\sqrt{Hz}$
Full Power Bandwidth	FPBW	$V_{PEAK} = 10V$	1, 2	+25°C	32	-	kHz
Minimum Closed Loop Stable Gain	CLSG	$R_L = 2k\Omega$ , $C_L = 50pF$	1	-55°C to +125°C	+1	-	V/V
Output Resistance	$R_{OUT}$	Open Loop	1	+25°C	-	270	$\Omega$
Quiescent Power Consumption	PC	$V_{OUT} = 0V$ , $I_{OUT} = 0mA$	1, 3	-55°C to +125°C	-	225	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  $FPBW = Slew\ Rate / (2\pi V_{PEAK})$ .
- Quiescent 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
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:**

95 x 99 x 19 mils ± 1 mils  
 2420 x 2530 x 483µm ± 25.4µm

**METALLIZATION:**

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

**GLASSIVATION:**

Type: Nitride (Si<sub>3</sub>N<sub>4</sub>) over Silox (SiO<sub>2</sub>, 5% Phos.)  
 Silox Thickness: 12kÅ ± 2kÅ  
 Nitride Thickness: 3.5kÅ ± 1.5kÅ

**WORST CASE CURRENT DENSITY:**

1.43 x 10<sup>5</sup> A/cm<sup>2</sup>

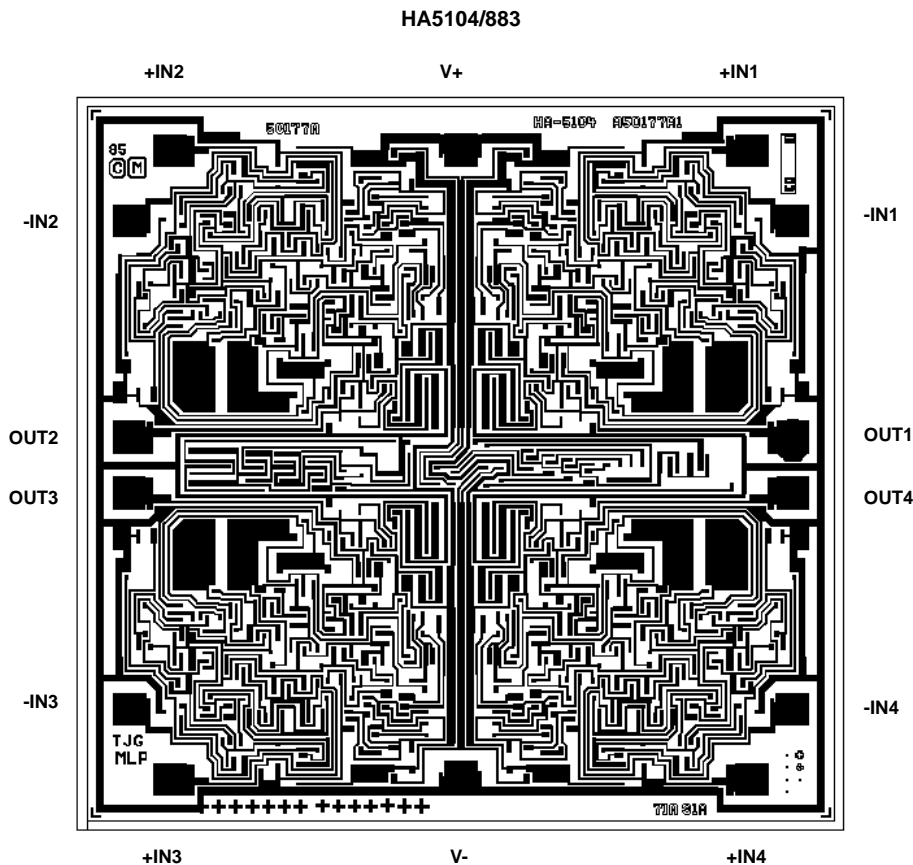
**SUBSTRATE POTENTIAL (Powered Up):**

Unbiased

**TRANSISTOR COUNT: 175**

**PROCESS: Bipolar Dielectric Isolation**

**Metallization Mask Layout**



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