HA-5222/883

Dual, Low Noise, Wideband, Precision Operational Amplifier

January 1996

Features

- **This Circuit is Processed in Accordance to MIL-STD-883 and is Fully Conformant Under the Provisions of Paragraph 1.2.1.**
- **Gain Bandwidth Product . . . . . 100MHz (Min)**
- **Unity Gain Bandwidth . . . . . 30MHz (Min) 40MHz (Typ)**
- **High Slew Rate . . . . . 25V/µs (Min) 37V/µs (Typ)**
- **Low Offset Voltage . . . . . 0.75mV (Max) 0.30mV (Typ)**
- **High Open Loop Gain . . . . . 106dB (Min) 128dB (Typ)**
- **Channel Separation (at 10kHz) . . . . . 110dB (Typ)**
- **Low Voltage Noise (at 1kHz) . . . . . 5.9nV/$\sqrt{Hz}$ (Max) 3.3nV/$\sqrt{Hz}$ (Typ)**
- **Low Current Noise (at 1kHz) . . . . . 2.7pA/$\sqrt{Hz}$ (Max) 1.3pA/$\sqrt{Hz}$ (Typ)**
- **High Output Current . . . . . ±30mA (Min) ±56mA (Typ)**
- **Low Supply Current (per Op Amp.) . . . . . 10mA (Max) 8mA (Typ)**

Applications

- **Precision Test Systems**
- **Active Filtering**
- **Small Signal Video**
- **Accurate Signal Processing**
- **RF Signal Conditioning**

Description

The HA-5222/883 is a dual, high performance, dielectrically isolated, monolithic op amp, featuring precision DC characteristics while providing excellent AC characteristics. Designed for audio, video, and other demanding applications, noise (3.3nV/$\sqrt{Hz}$ at 1kHz typ), total harmonic distortion (<0.005% typ), and DC errors are kept to a minimum.

The precision performance is shown by low offset voltage (0.3mV typ), low bias currents (40nA typ), low offset currents (15nA typ), and high open loop gain (128dB typ). The combination of these excellent DC characteristics with fast settling time (0.4µs typ) make the HA-5222/883 ideally suited for precision signal conditioning.

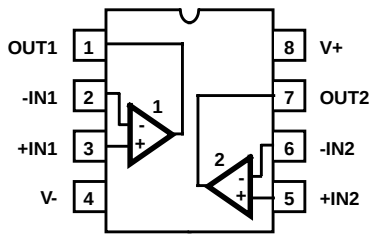
The unique design of the HA-5222/883 gives this device outstanding AC characteristics, including high unity gain bandwidth (40MHz typ) and high slew rate (37V/µs typ), not normally associated with precision op amps. Other key specifications include high CMRR (95dB typ) and high PSRR (100dB typ). The combination of these specifications will allow the HA-5222/883 to be used in RF signal conditioning as well as video amplifiers.

Ordering Information

PART NUMBER	TEMPERATURE RANGE	PACKAGE
HA7-5222/883	-55°C to +125°C	8 Lead CerDIP

Pinout

HA-5222/883
(CERDIP)
TOP VIEW



Spec Number **511062-883**
File Number **3717.1**

Absolute Maximum Ratings

Voltage Between V+ and V- Terminals 36V
Differential Input Voltage. 5V
Voltage at Either Input Terminal . . . . . V+ to V-
Peak Output Current (Pulsed at 1ms, 10% Duty Cycle) 100mA
Continuous Output Current. . . . . Short Circuit Protected
Junction Temperature . . . . . +175°C
Storage Temperature Range . . . . . -65°C to +150°C
ESD Rating. . . . . <2000V
Lead Temperature (Soldering 10s) . . . . . +300°C

Thermal Information (Typical)

Thermal Resistance	θ_{JA}	θ_{JC}
CerDIP Package	96°C/W	16°C/W

Package Power Dissipation Limit at +75°C
CerDIP Package 1.04W
Package Power Dissipation Derating Factor Above +75°C
CerDIP Package . . . . . 10.4mW/°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
Operating Supply Voltage . . . . . ±5V to ±15V

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

TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS

Device Tested at: $V_{SUPPLY} = \pm15V$, $R_{LOAD} = 1k\Omega$, $V_{OUT} = 0V$, 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	-0.75	0.75	mV
			2, 3	+125°C, -55°C	-1.5	1.5	mV
Input Bias Current	$+I_B$	$V_{CM} = 0V$, $+R_S = 100.1k\Omega$, $-R_S = 100\Omega$	1	+25°C	-80	80	nA
			2, 3	+125°C, -55°C	-200	200	nA
	$-I_B$	$V_{CM} = 0V$, $+R_S = 100\Omega$, $-R_S = 100.1k\Omega$	1	+25°C	-80	80	nA
			2, 3	+125°C, -55°C	-200	200	nA
Input Offset Current	I_{IO}	$V_{CM} = 0V$, $+R_S = 100.1k\Omega$, $-R_S = 100.1k\Omega$	1	+25°C	-50	50	nA
			2, 3	+125°C, -55°C	-150	150	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	4	+25°C	106	-	dB
			5, 6	+125°C, -55°C	100	-	dB
	$-A_{VOL}$	$V_{OUT} = 0V$ and -10V	4	+25°C	106	-	dB
			5, 6	+125°C, -55°C	100	-	dB
Common Mode Rejection Ratio	+CMRR	$\Delta V_{CM} = +10V$, V+ = +5V, V- = -25V, $V_{OUT} = -10V$	1	+25°C	88	-	dB
			2, 3	+125°C, -55°C	86	-	dB
	-CMRR	$\Delta V_{CM} = -10V$, V+ = +25V, V- = -5V, $V_{OUT} = +10V$	1	+25°C	88	-	dB
			2, 3	+125°C, -55°C	86	-	dB
Output Voltage Swing	$+V_{OUT}$	$R_L = 1k\Omega$	4	+25°C	12.0	-	V
			5, 6	+125°C, -55°C	11.5	-	V
	$-V_{OUT}$	$R_L = 1k\Omega$	4	+25°C	-	-12.0	V
			5, 6	+125°C, -55°C	-	-11.5	V

TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)

Device Tested at: V_{SUPPLY} = ±15V, R_{LOAD} = 1kΩ, V_{OUT} = 0V, Unless Otherwise Specified.

PARAMETERS	SYMBOL	CONDITIONS	GROUP A SUBGROUPS	TEMPERATURE	LIMITS		UNITS
					MIN	MAX	
Output Current	$+I_{OUT}$	V_{OUT} = +10V, R_L = 1kΩ	4	+25°C	30	-	mA
			5, 6	+125°C, -55°C	30	-	mA
	$-I_{OUT}$	V_{OUT} = -10V, R_L = 1kΩ	4	+25°C	-	-30	mA
			5, 6	+125°C, -55°C	-	-30	mA
Quiescent Power Supply Current	$+I_{CC}$	V_{OUT} = 0V, I_{OUT} = 0mA	1	+25°C	-	20	mA
			2, 3	+125°C, -55°C	-	22	mA
	$-I_{CC}$	V_{OUT} = 0V, I_{OUT} = 0mA	1	+25°C	-20	-	mA
			2, 3	+125°C, -55°C	-22	-	mA
Power Supply Rejection Ratio	+PSRR	ΔV_{SUP} = 10V, V+ = +20V, V- = -15V, V+ = +10V, V- = -15V	1	+25°C	90	-	dB
			2, 3	+125°C, -55°C	86	-	dB
	-PSRR	ΔV_{SUP} = 10V, V+ = +15V, V- = -20V, V+ = +15V, V- = -10V	1	+25°C	90	-	dB
			2, 3	+125°C, -55°C	86	-	dB

TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS

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

TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTIC

Device Characterized at: V_{SUPPLY} = ±15V, R_{LOAD} = 1kΩ, Unless Otherwise Specified.

PARAMETERS	SYMBOL	CONDITIONS	NOTES	TEMPERATURE	LIMITS		UNITS
					MIN	MAX	
Input Noise Voltage Density	E_N	R_S = 0Ω, f_O = 10Hz	1, 5	+25°C	-	16.0	nV/√Hz
		R_S = 0Ω, f_O = 100Hz	1, 5	+25°C	-	6.6	nV/√Hz
		R_S = 0Ω, f_O = 1kHz	1, 5	+25°C	-	5.9	nV/√Hz
Input Noise Current Density	I_N	R_S = 500kΩ, f_O = 10Hz	1, 5	+25°C	-	24.0	pA/√Hz
		R_S = 500kΩ, f_O = 100Hz	1, 5	+25°C	-	6.6	pA/√Hz
		R_S = 500kΩ, f_O = 1kHz	1, 5	+25°C	-	2.7	pA/√Hz
Gain Bandwidth Product	GBWP	V_{OUT} = 200mV_{P-P}, f_O = 100kHz	1	+25°C	100	-	MHz
				-55°C to +125°C	88	-	MHz
Unity Gain Bandwidth	UGBW	V_{OUT} = 200mV	1	+25°C	30	-	MHz
				-55°C to +125°C	25	-	MHz
Slew Rate	±SR	V_{OUT} = ±2.5V, C_L = 50pF	1	-55°C to +125°C	25	-	V/µs
Full Power Bandwidth	FPBW	V_{PEAK} = 10V	1, 2	-55°C to +125°C	398	-	kHz

TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTIC (Continued)

Device Characterized at: V_{SUPPLY} = ±15V, R_{LOAD} = 1kΩ, Unless Otherwise Specified.

PARAMETERS	SYMBOL	CONDITIONS	NOTES	TEMPERATURE	LIMITS		UNITS
					MIN	MAX	
Minimum Closed Loop Stable Gain	CLSG	R_L = 1kΩ, C_L = 50pF	1	-55°C to +125°C	1	-	V/V
Rise and Fall Time	t_R, t_F	V_{OUT} = ±100mV	1, 4	+25°C	-	20	ns
				-55°C to +125°C	-	35	ns
Overshoot	±OS	V_{OUT} = ±100mV	1	+25°C	-	25	%
				-55°C to +125°C	-	30	%
Power Consumption	PC	V_{OUT} = 0V, I_{OUT} = 0mA	1, 3	-55°C to +125°C	-	660	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.).
4. Measured between 10% and 90% points.
5. Input Noise Voltage Density and Input Noise Current Density limits are based on characterization data.

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:

1. PDA applies to Subgroup 1 only.

Die Characteristics

DIE DIMENSIONS:
78 x 185 x 19 mils ± 1 mils
1980 x 4690 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:
$4.2 \times 10^4 A/cm^2$

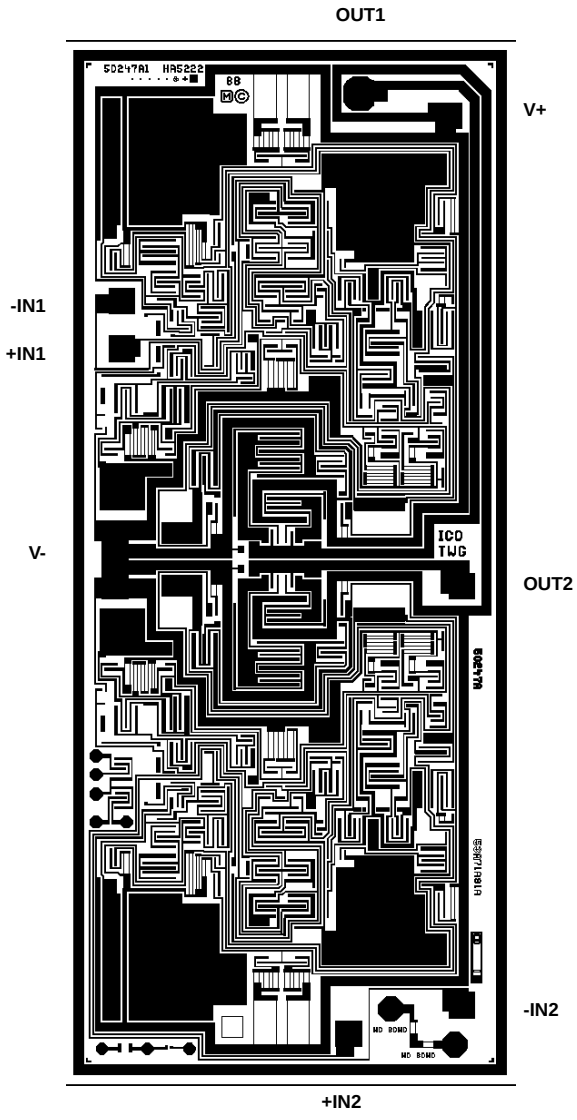
SUBSTRATE POTENTIAL (Powered Up): V-

TRANSISTOR COUNT: 128

PROCESS: Bipolar Dielectric Isolation

Metallization Mask Layout

HA-5222/883



Spec Number **511062-883**

DESIGN INFORMATION (Continued)

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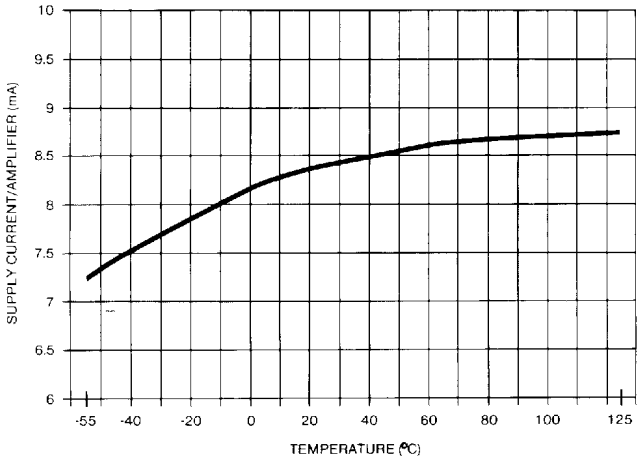
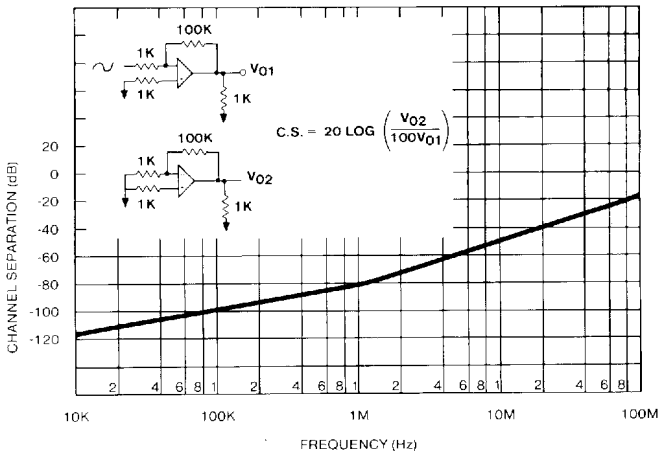
Typical Performance Curves Unless Otherwise Specified: $T_A = +25^oC$, $V_{SUPPLY} = \pm15V$

SUPPLY CURRENT/AMPLIFIER vs TEMPERATURE



CHANNEL SEPARATION vs FREQUENCY



TYPICAL PERFORMANCE CHARACTERISTICS

Device Characterized at: Supply Voltage = ±15V, $R_L = 1k\Omega$, $C_L = 50pF$, Unless Otherwise Specified

PARAMETERS	CONDITIONS	TEMPERATURE	TYPICAL	UNITS
Input Offset Voltage	See Table 1	+25°C	0.30	mV
		Full	0.35	mV
Average Offset Voltage Drift	See Table 1	Full	0.50	µV/°C
Input Bias Current	See Table 1	+25°C	40	nA
		Full	70	nA
Input Offset Current	See Table 1	+25°C	15	nA
		Full	30	nA
Differential Input Resistance	See Table 1	+25°C	70	kΩ
Input Noise Voltage	f_O = 0.1Hz to 10Hz	+25°C	0.33	μV_{P-P}
Input Noise Voltage Density	f_O = 10Hz	+25°C	6.4	$nV/\sqrt{Hz}$
	f_O = 100Hz	+25°C	3.7	$nV/\sqrt{Hz}$
	f_O = 1kHz	+25°C	3.3	$nV/\sqrt{Hz}$
Input Noise Current Density	f_O = 10Hz	+25°C	8	$pA/\sqrt{Hz}$
	f_O = 100Hz	+25°C	2.7	$pA/\sqrt{Hz}$
	f_O = 1kHz	+25°C	1.3	$pA/\sqrt{Hz}$
THD & N	See Note 1	+25oC	0.005	%
Large Signal Voltage Gain	V_{OUT} = 0V to ±10V	+25oC	128	dB
		Full	120	dB

DESIGN INFORMATION (Continued)

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TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

Device Characterized at: Supply Voltage = ±15V, R_L = 1kΩ, C_L = 50pF, Unless Otherwise Specified

PARAMETERS	CONDITIONS		TEMPERATURE	TYPICAL	UNITS
Common Mode Rejection Ratio	ΔV_{CM} = ±10V		Full	95	dB
Unity Gain Bandwidth	-3dB		+25°C	40	MHz
			+125°C	33	MHz
			-55°C	50	MHz
Gain Bandwidth Product	1kHz to 400kHz		+25°C	140	MHz
			+125°C	115	MHz
			-55°C	160	MHz
Minimum Gain Stability			Full	1	V/V
Output Voltage Swing	R_L = 333Ω		Full	110	V
	R_L = 1K		+25°C	112.5	V
			Full	112.1	V
Output Current	V_{OUT} = ±10V		Full	156	mA
Output Resistance			+25°C	10	V
Full Power Bandwidth	FPBW = SR/2πV_{PEAK}, V_{PEAK} = 10V		+25°C	398	kHz
Channel Separation	f_O = 10kHz		+25°C	110	dB
Slew Rate	V_{OUT} = ±2.5V		+25°C	37	V/µs
			+125°C	39	V/µs
			-55°C	36	V/µs
Rise Time	V_{OUT} = ±100mV		+25°C	16	ns
			+125°C	17	ns
			-55°C	17	ns
Overshoot	V_{OUT} = ±100mV		+25°C	12	%
			+125°C	11	%
			-55°C	12	%
Settling Time	$10V_{STEP}$, A_V = -1	0.1%	+25°C	0.4	µs
		0.01%	+25°C	1.5	µs
Power Supply Rejection Ratio	ΔV_S = ±10V to ±20V		Full	100	dB
Supply Current	Quiescent, V_{OUT} = 0V, I_{OUT} = 0mA		Full	8	mA/Op Amp
Minimum Supply Voltage	Functional Operation Only. Other Parameters May Vary.		+25°C	15	V

NOTE:

1. A_{VCL} = 10, f_O = 1kHz, V_{OUT} = 5Vrms, R_L = 600Ω, 10Hz to 100kHz, Minimum resolution of test equipment is 0.005%.

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