HARRIS SEMICONDUCTOR

HA-5221/883

Low Noise, Wideband, Precision 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.
- 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)
- Low Voltage Noise (at 1kHz) ..... 5.8nV/√Hz (Max) 3.6nV/√Hz (Typ)
- Low Current Noise (at 1kHz) ..... 2.0pA/√Hz (Max) 1.4pA/√Hz (Typ)
- High Output Current ..... ±30mA (Min) ±56mA (Typ)
- Low Supply Current ..... 10mA (Max) 8mA (Typ)

Applications

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

Description

The HA-5221/883 is a 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 (3.6nV/√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-5221/883 ideally suited for precision signal conditioning.

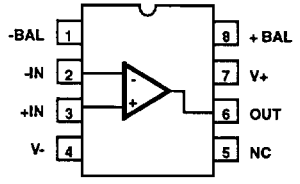
The unique design of the HA-5221/883 gives this device outstanding AC characteristics, including high unity gain bandwidth (40MHz typ) and high slew rate (37V/µs typ), not normally associated with precision op amps. Other key specifications include high CMRR (95dB typ) and high PSRR (100dB typ). The combination of these specifications will allow the HA-5221/883 to be used in RF signal conditioning as well as video amplifiers.

Ordering Information

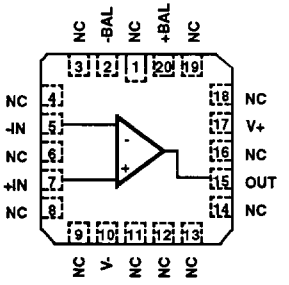
PART NUMBER	TEMPERATURE RANGE	PACKAGE
HA2-5221/883	-55°C to +125°C	8 Pin Can
HA4-5221/883	-55°C to +125°C	20 Lead Ceramic LCC
HA7-5221/883	-55°C to +125°C	8 Lead CerDIP

Pinouts

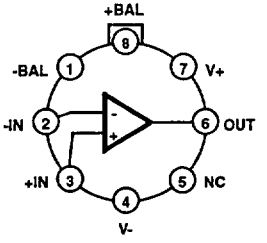
HA-5221/883
(CERDIP)
TOP VIEW



HA-5221/883
(CLCC)
TOP VIEW



HA-5221/883
(METAL CAN)
TOP VIEW



CAUTION: These devices are sensitive to electrostatic discharge. Users should follow proper I.C. Handling Procedures.

Spec Number 511061-883

File Number 3716

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

Thermal Resistance	θ_{JA}	θ_{JC}
CerDIP Package	110°C/W	27°C/W
Ceramic LCC Package	64°C/W	13°C/W
Metal Can Package	148°C/W	67°C/W

Package Power Dissipation Limit at +75°C
CerDIP Package 0.91W
Ceramic LCC Package 1.56W
Metal Can Package 0.68W
Package Power Dissipation Derating Factor Above +75°C
CerDIP Package . . . . . 9.1mW/°C
Ceramic LCC Package . . . . . 15.6mW/°C
Metal Can Package . . . . . 6.8mW/°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 . . . . . ±10V to ±15V
$V_{INCM} \leq 1/2\ (V+ - V-)$
$R_L \geq 1k\Omega$

TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS

Device Tested at: $V_{SUPPLY} = \pm 15V$, $R_{LOAD} = 1k\Omega$, $V_{OUT} = 0V$, 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 MIN	LIMITS MAX	UNITS
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	-	10	mA
			2, 3	+125°C, -55°C	-	11	mA
	$-I_{CC}$	V_{OUT} = 0V, I_{OUT} = 0mA	1	+25°C	-10	-	mA
			2, 3	+125°C, -55°C	-11	-	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
Offset Voltage Adjustment	$+V_{IO}$Adj	Note 1	1	+25°C	V_{IO}-1	-	mV
			2, 3	+125°C, -55°C	V_{IO}-1	-	mV
	$-V_{IO}$Adj	Note 1	1	+25°C	V_{IO}+1	-	mV
			2, 3	+125°C, -55°C	V_{IO}+1	-	mV

NOTE:

1. Offset adjustment range is [V_{IO} (Measured ±1mV] minimum referred to output. This test is for functionality only to assure adjustment through 0V.

TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS

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

TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS

Device Characterized at: V_{SUPPLY} = ±15V, R_{LOAD} = 1kΩ, C_{LOAD} = 50pF, Unless Otherwise Specified.

PARAMETERS	SYMBOL	CONDITIONS	NOTES	TEMPERATURE	LIMITS MIN	LIMITS MAX	UNITS
Input Noise Voltage Density	E_N	R_S = 0Ω, f_O = 10Hz	1, 5	+25°C	-	24.0	$nV/\sqrt{Hz}$
		R_S = 0Ω, f_O = 100Hz	1, 5	+25°C	-	8.0	$nV/\sqrt{Hz}$
		R_S = 0Ω, f_O = 1kHz	1, 5	+25°C	-	5.8	$nV/\sqrt{Hz}$
Input Noise Current Density	I_N	R_S = 500kΩ, f_O = 10Hz	1, 5	+25°C	-	11.5	$pA/\sqrt{Hz}$
		R_S = 500kΩ, f_O = 100Hz	1, 5	+25°C	-	6.0	$pA/\sqrt{Hz}$
		R_S = 500kΩ, f_O = 1kHz	1, 5	+25°C	-	2.0	$pA/\sqrt{Hz}$
Gain Bandwidth Product	GBWP	V_{OUT} = 200mV_{P-P}, f_O = 100kHz	1	+25°C	100	-	MHz
				-55°C to +125°C	90	-	MHz
Unity Gain Bandwidth	UGBW	V_{OUT} = 200mV	1	+25°C	30	-	MHz
				-55°C to +125°C	25	-	MHz

TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)

Device Characterized at: V_{SUPPLY} = ±15V, R_{LOAD} = 1kΩ, C_{LOAD} = 50pF, Unless Otherwise Specified.

PARAMETERS	SYMBOL	CONDITIONS	NOTES	TEMPERATURE	LIMITS MIN	LIMITS MAX	UNITS
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
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
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:
72 x 94 x 19 mils ± 1 mils
1840 x 2400 x 483µm ± 25.4µm

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

GLASSIVATION:
Type: Nitride (Si_3N_4) over Silox (SiO_2, 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: 62

PROCESS: Bipolar Dielectric Isolation

Metallization Mask Layout

HA-5221/883