HA-5177/883

November 2004

Ultra Low Offset Voltage 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 . . . . . .60μV (Max)**
  10μV (Typ)
- **Low Offset Voltage Drift . . . . . 0.6μV/°C (Max)**
  0.1μV/°C (Typ)
- **High Voltage Gain . . . . . .126dB (Min)**
  150dB (Typ)
- **High CMRR . . . . . .110dB (Min)**
  140dB (Typ)
- **High PSRR . . . . . .110dB (Min)**
  135dB (Typ)
- **Low Noise . . . . . .11nV/√Hz (Max)**
  9nV/√Hz (Typ)
- **Low Power Consumption . . . . . .51mW (Max)**
- **Wide Gain Bandwidth Product . . . . . .2MHz (Min)**
- **Unity Gain Stable**

Applications

- **High Gain Instrumentation Amplifiers**
- **Precision Control Systems**
- **Precision Integrators**
- **High Resolution Data Converters**
- **Precision Threshold Detectors**
- **Low Level Transducer Amplifiers**

Description

The HA-5177/883 is a monolithic, all bipolar, precision operational amplifier, utilizing Intersil Dielectric Isolation and advance processing techniques. This design features a combination of precision input characteristics, wide gain bandwidth (2MHz) and high speed (0.5V/μs min) and is an improved version of the HA-5135/883.

The HA-5177/883 uses advanced matching techniques and laser trimming to produce low offset voltage (10μV typ, 60μV max) and low offset voltage drift (0.1μV/°C typ, 0.6μV/°C max). This design also features low voltage noise (9nV/√Hz typ), Low current noise (0.32pA/√Hz typ), nanoamp input currents, and 126dB minimum gain.

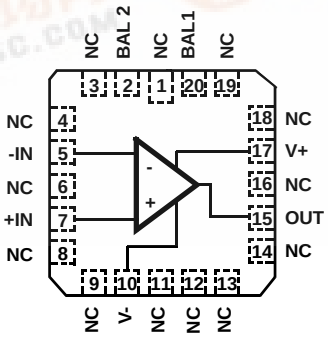
These outstanding features along with high CMRR (140dB typ, 110dB min) and high PSRR (135dB typ, 110dB min) make this unity gain stable amplifier ideal for high resolution data acquisition systems, precision integrators, and low level transducer amplifiers.

Part Number Information

PART NUMBER	TEMPERATURE RANGE	PACKAGE
HA4-5177/883	-55°C to +125°C	20 Lead Ceramic LCC

Pinout

HA-5177/883
(CLCC)
TOP VIEW



Absolute Maximum Ratings

Voltage Between V+ and V- Terminals 44V
Differential Input Voltage (Note 1). 7V
Voltage at Either Input Terminal . . . . . V+ to V-
Input Current. 25mA
Output Current . . . . . Full Short Circuit Protection
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}
Ceramic LCC Package	80°C/W	28°C/W

Package Power Dissipation Limit at +75°C for $T_J \leq +175°C$
Ceramic LCC Package 1.54W
Package Power Dissipation Derating Factor Above +75°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.

NOTE:

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
Operating Supply Voltage . . . . . ±15V

$V_{INCM} \leq 1/2\ (V+ - V-)$
$R_L \geq 600\Omega$

TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS

Device Tested at: $V_{SUPPLY} = \pm15V$, $R_{SOURCE} = 50\Omega$, $R_{LOAD} = 100k\Omega$, $V_{OUT} = 0V$, 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	-60	60	µV
			2, 3	+125°C, -55°C	-100	100	µV
Input Bias Current	I_B	$V_{CM} = 0V$, $R_S = 10k\Omega, 50\Omega$ $\left(\frac{\lvert+I_B\rvert + \lvert-I_B\rvert}{2}\right)$	1	+25°C	-6	6	nA
			2, 3	+125°C, -55°C	-8	8	nA
Input Offset Current	I_{IO}	$V_{CM} = 0V$, $+R_S = 10k\Omega$, $-R_S = 10k\Omega$	1	+25°C	-6	6	nA
			2, 3	+125°C, -55°C	-8	8	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, $R_L = 2k\Omega$	4	+25°C	126	-	dB
			5, 6	+125°C, -55°C	120	-	dB
	$-A_{VOL}$	$V_{OUT} = 0V$ and -10V, $R_L = 2k\Omega$	4	+25°C	126	-	dB
			5, 6	+125°C, -55°C	120	-	dB
Common Mode Rejection Ratio	+CMRR	$\Delta V_{CM} = 10V$, V+ = +5V, V- = - 25V, $V_{OUT} = -10$	1	+25°C	116	-	dB
			2, 3	+125°C, -55°C	110	-	dB
	-CMRR	$\Delta V_{CM} = 10V$, V+ = +25V, V- = - 5V, $V_{OUT} = +10$	1	+25°C	116	-	dB
			2, 3	+125°C, -55°C	110	-	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
	$+V_{OUT2}$	$R_L = 600\Omega$	4	+25°C	10	-	V
	$-V_{OUT2}$	$R_L = 600\Omega$	4	+25°C	-	-10	V

TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)

Device Tested at: V_{SUPPLY} = ±15V, R_{SOURCE} = 50Ω, R_{LOAD} = 100kΩ, 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	4	+25°C	15	-	mA
			5, 6	+125°C, -55°C	15	-	mA
	$-I_{OUT}$	V_{OUT} = +10V	4	+25°C	-	-15	mA
			5, 6	+125°C, -55°C	-	-15	mA
Quiescent Power Supply Current	$+I_{CC}$	V_{OUT} = 0V, I_{OUT} = 0mA	1	+25°C	-	1.7	mA
			2, 3	+125°C, -55°C	-	1.7	mA
	$-I_{CC}$	V_{OUT} = 0V, I_{OUT} = 0mA	1	+25°C	-1.7	-	mA
			2, 3	+125°C, -55°C	-1.7	-	mA
Power Supply Rejection Ratio	+PSRR	ΔV_{SUP} = 15V, V+ = +5V, V- = - 15V, V+ = +20V, V- = - 15V	1	+25°C	110	-	dB
			2, 3	+125°C, -55°C	110	-	dB
	-PSRR	ΔV_{SUP} = 15V, V+ = +15V, V- = - 5V, V+ = +15V, V- = - 20V	1	+25°C	110	-	dB
			2, 3	+125°C, -55°C	110	-	dB
Offset Voltage Adjustment	$+V_{IO}$Adj	Note 2	1	+25°C	0.3	-	mV
			2, 3	+125°C, -55°C	0.3	-	mV
	$-V_{IO}$Adj	Note 2	1	+25°C	-	-0.3	mV
			2, 3	+125°C, -55°C	-	-0.3	mV

NOTES:

1. The input stage has series 500Ω resistors along with back to back diodes. This provides large differential input voltage protection for a slight increase in noise voltage.
2. This test is for functionality only to assure adjustment through 0V.

TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS

Device Tested at: V_{SUPPLY} = ±15V, R_{SOURCE} = 50Ω, R_{LOAD} = 2kΩ, C_{LOAD} = 50pF, A_{VCL} = +1V/V, Unless Otherwise Specified.

PARAMETERS	SYMBOL	CONDITIONS	GROUP A SUBGROUPS	TEMPERATURE	LIMITS MIN	LIMITS MAX	UNITS
Slew Rate	+SR	V_{OUT} = -3V to +3V, V_{IN} S.R. ≤ 25V/µs	7	+25°C	0.5	-	V/µs
	-SR	V_{OUT} = +3V to -3V, V_{IN} S.R. ≤ 25V/µs	7	+25°C	0.5	-	V/µs
Rise and Fall Time	t_R	V_{OUT} = 0 to +200mV 10% ≤ T_R ≤ 90%	7	+25°C	-	420	ns
	t_F	V_{OUT} = 0 to -200mV 10% ≤ T_F ≤ 90%	7	+25°C	-	420	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} = ±15V, R_{LOAD} = 2kΩ, C_{LOAD} = 50pF, A_V = +1V/V, 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	-	0.6	µV/°C
Average Offset Current Drift	$I_{IO}TC$	Versus Temperature	1	-55°C to +125°C	-	40	pA/°C
Average Bias Current Drift	I_RTC	Versus Temperature	1	-55°C to +125°C	-	40	pA/°C
Differential Input Resistance	R_{IN}	V_{CM} = 0V	1	+25°C	20	-	MΩ
Low Frequency Peak-to-Peak Noise Voltage	E_{NP-P}	0.1Hz to 10Hz	1	+25°C	-	0.6	μV_{P-P}
Low Frequency Peak-to-Peak Noise Current	I_{NP-P}	0.1Hz to 10Hz	1	+25°C	-	45	pA_{P-P}
Input Noise Voltage Density	E_N	R_S = 20Ω, f_O = 10Hz	1	+25°C	-	18	$nV/\sqrt{Hz}$
		R_S = 20Ω, f_O = 100Hz	1	+25°C	-	13	$nV/\sqrt{Hz}$
		R_S = 20Ω, f_O = 1kHz	1	+25°C	-	11	$nV/\sqrt{Hz}$
Input Noise Current Density	I_N	R_S = 2MΩ, f_O = 10Hz	1	+25°C	-	4	$pA/\sqrt{Hz}$
		R_S = 2MΩ, f_O = 100Hz	1	+25°C	-	2.3	$pA/\sqrt{Hz}$
		R_S = 2MΩ, f_O = 1kHz	1	+25°C	-	1	$pA/\sqrt{Hz}$
Gain Bandwidth Product	GBWP	V_O = 100mV, 1Hz ≤ f_O ≤ 100kHz	1	+25°C	2	-	MHz
Full Power Bandwidth	FPBW	V_{PEAK} = 10V	1, 2	+25°C	8	-	kHz
Minimum Closed Loop Stable Gain	CLSG	R_L = 2kΩ, C_L = 50pF	1	-55°C to +125°C	+1	-	V/V
Settling Time	t_S	To 0.1% for a 10V Step	1	+25°C	-	15	µs
Output Resistance	R_{OUT}	Open Loop	1	+25°C	-	70	Ω
Power Consumption	PC	V_{OUT} = 0V, I_{OUT} = 0mA	1, 3	-55°C to +125°C	-	51	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.)

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.

Die Characteristics

DIE DIMENSIONS:
72 x 103 x 19 mils ± 1 mils
1840 x 2620 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:
$6.0 \times 10^4 A/cm^2$

SUBSTRATE POTENTIAL (Powered Up): V-

TRANSISTOR COUNT: 71

PROCESS: Bipolar Dielectric Isolation

Metallization Mask Layout

HA-5177/883