HA-5142/883

July 1994

Dual, Ultra Low Power 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 Supply Current at V_S = +5V. . . .(+25^{o}C) 160μA (Max) (Full) 200μA (Max)**
- **Wide Supply Voltage Range . . . . . .Single 3V to 30V or Dual $\pm$1.5 to $\pm$15V**
- **High Slew Rate. . . . . 0.8V/μs (Min) 1.5V/μs (Typ)**
- **High Gain . . . . . 20kV/V (Min) 75kV/V (Typ)**
- **Low Noise (1kHz) . . . . . 20nV/$\sqrt{Hz}$ (Typ)**
- **100% Tested at $\pm$15V and +5V, 0V Power Supplies**
- **Unity Gain Stable**
- **Dielectric Isolation**

Applications

- **Portable Instruments**
- **Meter Amplifiers**
- **Telephone Headsets**
- **Microphone Amplifiers**
- **Instrumentation**
- **For Further Design Ideas See Application Note AN544**

Description

The HA-5142/883 dual, ultra-low power operational amplifier provides AC and DC performance characteristics similar to, or better than most general purpose amplifiers while only drawing 1/30 of the supply current of most general purpose amplifiers. This amplifier is well suited to applications which require low power dissipation and good electrical characteristics.

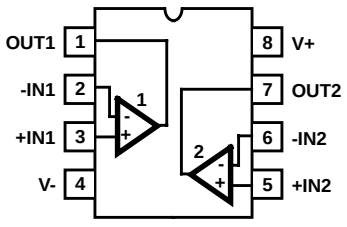
The HA-5142/883 provides accurate signal processing by virtue of their low input offset voltage (6mV), low input bias current (100nA), high open loop gain (20kV/V) and low noise (20nV/$\sqrt{Hz}$). These characteristics coupled with a 1.5V/μs slew rate and a 24kHz bandwidth make the HA-5142/883 ideal for use in low power instrumentation, audio amplifier and active filter designs.

Ordering Information

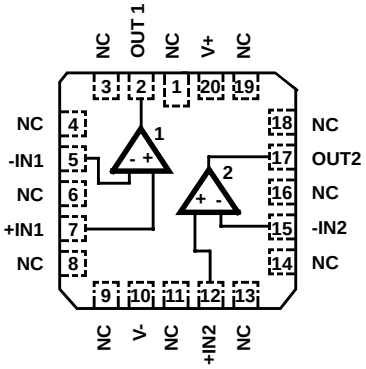
PART NUMBER	TEMPERATURE RANGE	PACKAGE
HA7-5142/883	-55^{o}C to +125^{o}C	8 Lead CerDIP
HA2-5142/883	-55^{o}C to +125^{o}C	8 Pin Can
HA4-5142/883	-55^{o}C to +125^{o}C	20 Lead Ceramic LCC

Pinouts

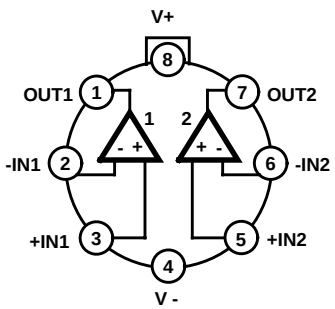
HA-5142/883 (CERDIP)
TOP VIEW



HA-5142/883 (CLCC)
TOP VIEW



HA-5142/883 (METAL CAN)
TOP VIEW



CAUTION: These devices are sensitive to electrostatic discharge; follow proper IC Handling Procedures.

Spec Number **511035-883**
File Number **3732.1**

Absolute Maximum Ratings

Voltage Between V+ and V- Terminals 35V
Differential Input Voltage 7V
Voltage at Either Input Terminal . . . . . V+ to V-
Output Current . . . . . .Full Short Circuit Protection
Output Current Duration . . . . . 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}
CerDIP Package	115°C/W	28°C/W
Ceramic LCC Package	65°C/W	15°C/W
Metal Can Package	155°C/W	67°C/W

Package Power Dissipation Limit at +75°C for $T_J \leq +175°C$
CerDIP Package 870mW
Ceramic LCC Package 1.54W
Metal Can Package 645mW
Package Power Dissipation Derating Factor Above +75°C
CerDIP Package . . . . . 8.7mW/°C
Ceramic LCC Package . . . . . 15.4mW/°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.

Operating Conditions

Operating Temperature Range . . . . . -55°C to +125°C
Operating Supply Voltage . . . . . ±1.5V to ±15V or 3V to 30V

$V_{INCM} \leq 1/2$ (V+ - V-)
$R_L \geq 50k\Omega$

TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS

Device Tested at: $R_{SOURCE} = 100\Omega$, $R_{LOAD} = 500k\Omega$, $V_{OUT} = 0V$, Unless Otherwise Specified.
Subscript 1 Refers to Supply Voltages (V±) = ±15V, Subscript 2 Refers to V+ = 5.0, V- = 0V

PARAMETERS	SYMBOL	CONDITIONS	GROUP A SUBGROUPS	TEMPERATURE	LIMITS MIN	LIMITS MAX	UNITS
Input Offset Voltage	V_{IO1}	$V_{CM} = 0V$	1	+25°C	-6	6	µV
			2, 3	+125°C, -55°C	-8	8	µV
	V_{IO2}	$V_{CM} = 0V$, $V_{OUT} = 1.4V$	1	+25°C	-6	6	µV
			2, 3	+125°C, -55°C	-8	8	µV
Input Bias Current	$+I_{B1}$	$V_{CM} = 0V$, $+R_S = 10k\Omega$, $-R_S = 100\Omega$	1	+25°C	-100	100	nA
			2, 3	+125°C, -55°C	-125	125	nA
	$-I_{B1}$	$V_{CM} = 0V$, $+R_S = 100\Omega$, $-R_S = 10k\Omega$	1	+25°C	-100	100	nA
			2, 3	+125°C, -55°C	-125	125	nA
	$+I_{B2}$	$V_{CM} = 0V, V_{OUT} = 1.4V$, $+R_S = 10k\Omega$, $-R_S = 100\Omega$	1	+25°C	-100	100	nA
			2, 3	+125°C, -55°C	-125	125	nA
	$-I_{B2}$	$V_{CM} = 0V, V_{OUT} = 1.4V$, $+R_S = 100\Omega$, $-R_S = 10k\Omega$	1	+25°C	-100	100	nA
			2, 3	+125°C, -55°C	-125	125	nA
Input Offset Current	I_{IO1}	$V_{CM} = 0V$, $+R_S = 10k\Omega$, $-R_S = 10k\Omega$	1	+25°C	-10	10	nA
			2, 3	+125°C, -55°C	-20	20	nA
	I_{IO2}	$V_{CM} = 0V, V_{OUT} = 1.4V$ $+R_S = 10k\Omega$, $-R_S = 10k\Omega$	1	+25°C	-10	10	nA
			2, 3	+125°C, -55°C	-20	20	nA
Common Mode Range	$+CMR_1$	V+ = +5V, V- = -25V	1	+25°C	10	-	V
			2, 3	+125°C, -55°C	10	-	V
	$-CMR_1$	V+ = +25V, V- = -5V	1	+25°C	-	-10	V
			2, 3	+125°C, -55°C	-	-10	V
	$+CMR_2$	V+ = +5V to +2V, V- = 0V to -3V, V_{OUT} = 1.4V to -1.6V	1	+25°C	3	-	V
			2, 3	+125°C, -55°C	3	-	V

TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)

Device Tested at: R_{SOURCE} = 100Ω, R_{LOAD} = 500kΩ, V_{OUT} = 0V, Unless Otherwise Specified.
Subscript 1 Refers to Supply Voltages (V±) = ±15V, Subscript 2 Refers to V+ = 5.0, V- = 0V

PARAMETERS	SYMBOL	CONDITIONS	GROUP A SUBGROUPS	TEMPERATURE	LIMITS		UNITS
					MIN	MAX	
Large Signal Voltage Gain	$+A_{VOL1}$	V_{OUT} = 0V and +10V, R_L = 50kΩ	4	+25°C	20	-	kV/V
			5, 6	+125°C, -55°C	15	-	kV/V
	$-A_{VOL1}$	V_{OUT} = 0V and -10V, R_L = 50kΩ	4	+25°C	20	-	kV/V
			5, 6	+125°C, -55°C	15	-	kV/V
	$+A_{VOL2}$	V_{OUT} = 1.4V and 2.5V, R_L = 50kΩ	4	+25°C	20	-	kV/V
			5, 6	+125°C, -55°C	15	-	kV/V
Common Mode Rejection Ratio	$+CMRR_1$	ΔV_{CM} = 10V, V+ = 5V, V- = -25V, V_{OUT} = -10V	1	+25°C	77	-	dB
			2, 3	+125°C, -55°C	77	-	dB
	$-CMRR_1$	ΔV_{CM} = 10V, V+ = 25V, V- = -5V, V_{OUT} = +10V	1	+25°C	77	-	dB
			2, 3	+125°C, -55°C	77	-	dB
	$+CMRR_2$	ΔV_{CM} = 0V to 3V, V+ = 2V, V- = -3V, V_{OUT} = -1.6V	1	+25°C	77	-	dB
			2, 3	+125°C, -55°C	77	-	dB
Output Voltage Swing	$+V_{OUT1}$	R_L = 50kΩ	1	+25°C	10	-	V
			2, 3	+125°C, -55°C	10	-	V
	$-V_{OUT1}$	R_L = 50kΩ	1	+25°C	-	-10	V
			2, 3	+125°C, -55°C	-	-10	V
	$+V_{OUT2}$	R_L = 50kΩ Terminated at 2.5V	1	+25°C	3.8	-	V
			2, 3	+125°C, -55°C	3.5	-	V
	$-V_{OUT2}$	R_L = 50kΩ Terminated at 2.5V	1	+25°C	-	1	V
			2, 3	+125°C, -55°C	-	1.2	V
Quiescent Power Supply Current (Both Amplifiers)	$+I_{CC1}$	V_{OUT} = 0V, I_{OUT} = 0mA	1	+25°C	-	300	µA
			2, 3	+125°C, -55°C	-	400	µA
	$-I_{CC1}$	V_{OUT} = 0V, I_{OUT} = 0mA	1	+25°C	-300	-	µA
			2, 3	+125°C, -55°C	-400	-	µA
	$-I_{CC2}$	V_{OUT} = 1.4V, I_{OUT} = 0mA	1	+25°C	-	160	µA
			2, 3	+125°C, -55°C	-	200	µA
Power Supply Rejection Ratio	$+PSRR_1$	ΔV_{SUP} = +10V, V+ = +10V, V- = -15V, V+ = +20V, V- = -15V	1	+25°C	77	-	dB
			2, 3	+125°C, -55°C	77	-	dB
	$-PSRR_1$	ΔV_{SUP} = +10V, V+ = +15V, V- = -10V, V+ = +15V, V- = -20V	1	+25°C	77	-	dB
			2, 3	+125°C, -55°C	77	-	dB
	$-PSRR_2$	ΔV_{SUP} = +10V, V+ = +5V, V- = 0V, V+ = +15V, V- = 0V	1	+25°C	77	-	dB
			2, 3	+125°C, -55°C	77	-	dB
Channel Separation	CS	R_L = 50kΩ	1	+25°C	80	-	dB
			2, 3	+125°C, -55°C	80	-	dB

TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS

Device Tested at: R_{SOURCE} = 50Ω, R_{LOAD} = 50kΩ, C_{LOAD} = 50pF, V_{OUT} = 0V, A_V = 1V/V, Unless Otherwise Specified. Subscript 1 Refers to Supply Voltages (V±) = ±15V; Subscript 2 Refers to V+ = 5.0V, V- = 0.0V.

PARAMETERS	SYMBOL	CONDITIONS	GROUP A SUBGROUPS	TEMPERATURE	LIMITS		UNITS
					MIN	MAX	
Slew Rate	$+SR_1$	V_{OUT} = -3V to +3V, V_{IN} S.R. ≤ 10V/µs	4	+25°C	0.8	-	V/µs
	$-SR_1$	V_{OUT} = +3V to -3V, V_{IN} S.R. ≤ 10V/µs	4	+25°C	0.8	-	V/µs
	$+SR_2$	V_{OUT} = 0V to +3V, V_{IN} S.R. ≤ 10V/µs	4	+25°C	0.8	-	V/µs
	$-SR_2$	V_{OUT} = +3V to 0V, V_{IN} S.R. ≤ 10V/µs	4	+25°C	0.8	-	V/µs

TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS

Device Tested at: R_{SOURCE} = 50Ω, R_{LOAD} = 50kΩ, C_{LOAD} = 50pF, A_V = 1V/V, Unless Otherwise Specified.
Subscript 1 Refers to Supply Voltages (V±) = ±15V; Subscript 2 Refers to V+ = 5.0V, V- = 0.0V.

PARAMETERS	SYMBOL	CONDITIONS	NOTES	TEMPERATURE	LIMITS		UNITS
					MIN	MAX	
Full Power Bandwidth	$FPBW_1$	V_{PEAK} = 10V	1, 2	+25°C	12.7	-	kHz
	$FPBW_2$	V_{PEAK} = 1.1V, V_{REF} = 2.5V	1, 2	+25°C	115.8	-	kHz
Minimum Closed Loop Stable Gain	CLSG	R_L = 50kΩ, C_L = 50pF	1	-55°C to +125°C	1	-	V/V
Quiescent Power Consumption	PC_1	V_{OUT} = 0V, I_{OUT} = 0mA	1, 3	-55°C to +125°C	-	12	mW
	PC_2	V_{OUT} = 1.4V, I_{OUT} = 0mA	1, 3	-55°C to +125°C	-	1	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. 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:

1. PDA applies to Subgroup 1 only.

Die Characteristics

DIE DIMENSIONS:
104 x 55 x 19 mils ± 1 mils
2650 x 1400 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:
0.6 x 10^5A/cm^2

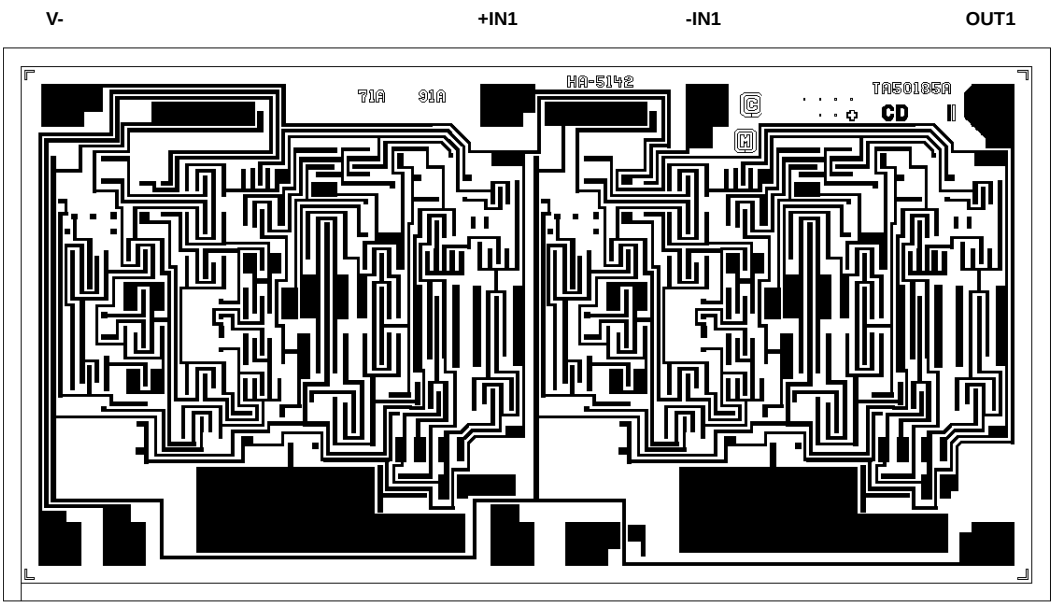
SUBSTRATE POTENTIAL (Powered Up): V-

TRANSISTOR COUNT: 72

PROCESS: Bipolar/JFET Dielectric Isolation

Metallization Mask Layout

HA-5142/883



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