

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 $V_S = +5V \dots (+25^\circ C)$ 160 μA (Max)
(Full) 200 μA (Max)
- Wide Supply Voltage Range Single 3V to 30V or
Dual ± 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

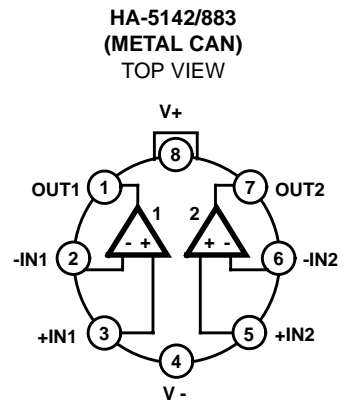
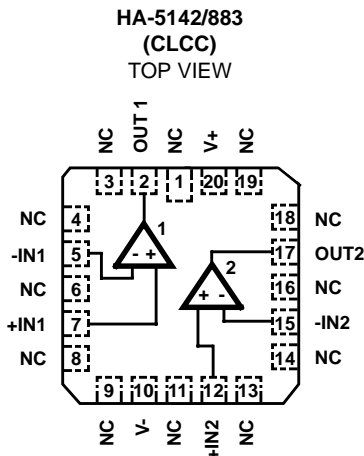
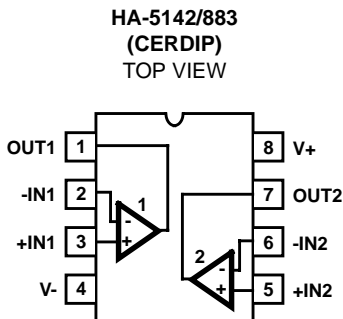
The HA-5142/883 dual, ultra-low power operational amplifier provides AC and DC performance characteristics similar to, or better than most general purpose amplifiers while only drawing 1/30 of the supply current of most general purpose amplifiers. This amplifier is well suited to applications which require 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°C to +125°C	8 Lead CerDIP
HA2-5142/883	-55°C to +125°C	8 Pin Can
HA4-5142/883	-55°C to +125°C	20 Lead Ceramic LCC

Pinouts



Specifications HA-5142/883

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 ≤ +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	$V_{INCM} \leq 1/2 (V+ - V-)$
Operating Supply Voltage	±1.5V to ±15V or 3V to 30V	$R_L \geq 50k\Omega$

TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS

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	
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 = 10kΩ, -R _S = 100Ω	1	+25°C	-100	100	nA
			2, 3	+125°C, -55°C	-125	125	nA
	-I _{B1}	V _{CM} = 0V, +R _S = 100Ω, -R _S = 10kΩ	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 = 10kΩ, -R _S = 100Ω	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 = 100Ω, -R _S = 10kΩ	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 = 10kΩ, -R _S = 10kΩ	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 = 10kΩ, -R _S = 10kΩ	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

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TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)

Device Tested at: $R_{SOURCE} = 100\Omega$, $R_{LOAD} = 500k\Omega$, $V_{OUT} = 0V$, Unless Otherwise Specified.

Subscript 1 Refers to Supply Voltages (V_{\pm}) = $\pm 15V$, 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 = 50k Ω	4	+25°C	20	-	kV/V
			5, 6	+125°C, -55°C	15	-	kV/V
	-A _{VOL1}	V _{OUT} = 0V and -10V, R _L = 50k Ω	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 = 50k Ω	4	+25°C	20	-	kV/V
			5, 6	+125°C, -55°C	15	-	kV/V
Common Mode Rejection Ratio	+CMRR ₁	$\Delta V_{CM} = 10V$, V ₊ = 5V, V ₋ = -25V, V _{OUT} = -10V	1	+25°C	77	-	dB
			2, 3	+125°C, -55°C	77	-	dB
	-CMRR ₁	$\Delta V_{CM} = 10V$, V ₊ = 25V, V ₋ = -5V, V _{OUT} = +10V	1	+25°C	77	-	dB
			2, 3	+125°C, -55°C	77	-	dB
	+CMRR ₂	$\Delta V_{CM} = 0V$ 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 = 50k Ω	1	+25°C	10	-	V
			2, 3	+125°C, -55°C	10	-	V
	-V _{OUT1}	R _L = 50k Ω	1	+25°C	-	-10	V
			2, 3	+125°C, -55°C	-	-10	V
	+V _{OUT2}	R _L = 50k Ω Terminated at 2.5V	1	+25°C	3.8	-	V
			2, 3	+125°C, -55°C	3.5	-	V
-V _{OUT2}	R _L = 50k Ω 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	$\Delta V_{SUP} = +10V$, V ₊ = +10V, V ₋ = -15V, V ₊ = +20V, V ₋ = -15V	1	+25°C	77	-	dB
			2, 3	+125°C, -55°C	77	-	dB
	-PSRR ₁	$\Delta V_{SUP} = +10V$, V ₊ = +15V, V ₋ = -10V, V ₊ = +15V, V ₋ = -20V	1	+25°C	77	-	dB
			2, 3	+125°C, -55°C	77	-	dB
	-PSRR ₂	$\Delta V_{SUP} = +10V$, 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 = 50k Ω	1	+25°C	80	-	dB
			2, 3	+125°C, -55°C	80	-	dB

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TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS

Device Tested at: $R_{SOURCE} = 50\Omega$, $R_{LOAD} = 50k\Omega$, $C_{LOAD} = 50pF$, $V_{OUT} = 0V$, $A_V = 1V/V$, Unless Otherwise Specified. Subscript 1 Refers to Supply Voltages (V_{\pm}) = $\pm 15V$; 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. $\leq 10V/\mu s$	4	+25°C	0.8	-	V/ μs
	-SR ₁	$V_{OUT} = +3V$ to $-3V$, V_{IN} S.R. $\leq 10V/\mu s$	4	+25°C	0.8	-	V/ μs
	+SR ₂	$V_{OUT} = 0V$ to $+3V$, V_{IN} S.R. $\leq 10V/\mu s$	4	+25°C	0.8	-	V/ μs
	-SR ₂	$V_{OUT} = +3V$ to $0V$, V_{IN} S.R. $\leq 10V/\mu s$	4	+25°C	0.8	-	V/ μs

TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS

Device Tested at: $R_{SOURCE} = 50\Omega$, $R_{LOAD} = 50k\Omega$, $C_{LOAD} = 50pF$, $A_V = 1V/V$, Unless Otherwise Specified. Subscript 1 Refers to Supply Voltages (V_{\pm}) = $\pm 15V$; 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	$R_L = 50k\Omega$, $C_L = 50pF$	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:

- 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 $FPBW = \text{Slew Rate}/(2\pi V_{PEAK})$.
- 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:

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 10⁵A/cm²

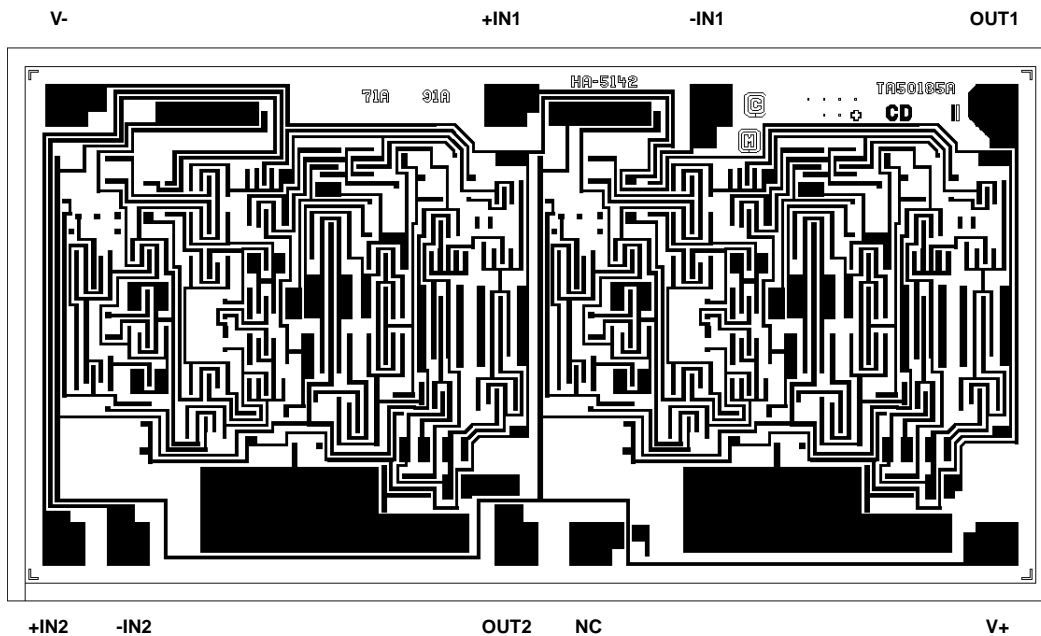
SUBSTRATE POTENTIAL (Powered Up): V-

TRANSISTOR COUNT: 72

PROCESS: Bipolar/JFET Dielectric Isolation

Metallization Mask Layout

HA-5142/883



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