

## Precision, High Slew Rate, Wideband Operational Amplifier

July 1997

### Features

- This Circuit is Processed in Accordance to MIL-STD-883 and is Fully Conformant Under the Provisions of Paragraph 1.2.1.
- High Slew Rate . . . . . 120V/μs (Typ)
- Low Offset Voltage . . . . . 300μV (Typ)  
900μV (Max)
- High Open Loop Gain . . . . . 130dB (Typ)  
114dB (Min)
- Gain Bandwidth Product . . . . . 150MHz (Typ)
- Low Voltage Noise at 1kHz . . . . . 8.3nV/√Hz (Typ)
- Minimum Gain Stability . . . . . ≥ 5 (Typ)

### Applications

- High Speed Instrumentation
- Data Acquisition Systems
- Analog Signal Conditioning
- Precision, Wideband Amplifiers
- Pulse/RF Amplifiers

### Description

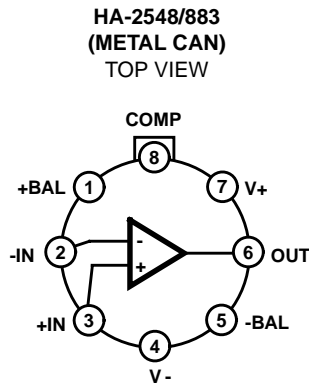
The HA-2548/883 is a monolithic op amp that offers a unique combination of bandwidth, slew rate, and precision specifications. These features can eliminate the need for composite op amp designs and external calibration circuitry.

Optimized for gains ≥5, the HA-2548/883 has a gain bandwidth product of 150MHz (typ) and a slew rate of 120V/μs (typ) while maintaining an extremely high open loop gain of 130dB (typ) and a low offset voltage of 300μV (typ). These specifications are achieved through uniquely designed input circuitry and a single ultra-high gain stage that minimizes the AC signal path. Capable of delivering over 30mA (min) of output current, the HA-2548/883 is ideal for precision, high speed applications such as signal conditioning, instrumentation, video/pulse amplifiers and buffers.

### Ordering Information

PART NUMBER	TEMP. RANGE (°C)	PACKAGE	PKG. NO.
HA2-2548/883	-55 to 125	8 Pin Can	T8.C

### Pinout



**Absolute Maximum Ratings**

Voltage Between V+ and V- Terminals . . . . . 40V  
 Differential Input Voltage . . . . . 5V  
 Voltage at Either Input Terminal . . . . . V+ to V-  
 Peak Output Current (< 10% Duty Cycle) . . . . . 60mA  
 Continuous Output Current . . . . . 40mA  
 ESD Rating . . . . . <2000V

**Operating Conditions**

Temperature Range . . . . . -55°C to 125°C  
 Supply Voltage . . . . . ±15V  
 $V_{INCM} \leq 1/2 (V+ - V-)$   
 $R_L \geq 1k\Omega$

*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.  $\theta_{JA}$  is measured with the component mounted on an evaluation PC board in free air.

**Thermal Information**

Thermal Resistance (Typical, Note 1)  $\theta_{JA}$   $\theta_{JC}$   
 Metal Can Package . . . . . 142°C/W 66°C/W  
 Package Power Dissipation Limit at 75°C  
 Metal Can Package . . . . . 0.70W  
 Package Power Dissipation Derating Factor Above 75°C  
 Metal Can Package . . . . . 7.0mW/°C  
 Maximum Junction Temperature . . . . . 175°C  
 Maximum Storage Temperature Range . . . . . -65°C to 150°C  
 Maximum Lead Temperature (Soldering 10s) . . . . . 300°C

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at:  $V_{SUPPLY} = \pm 15V$ ,  $R_{LOAD} = 100k\Omega$ ,  $V_{OUT} = 0V$ , Unless Otherwise Specified.

PARAMETERS	SYMBOL	CONDITIONS	GROUP A SUBGROUPS	TEMP. (°C)	MIN	MAX	UNITS
Input Offset Voltage	$V_{IO}$	$V_{CM} = 0V$	1	25	-900	900	$\mu V$
			2, 3	125, -55	-1200	1200	$\mu V$
Input Bias Current	$+I_B$	$V_{CM} = 0V$ , $+R_S = 100.1k\Omega$ , $-R_S = 100\Omega$	1	25	-50	50	nA
			2, 3	125, -55	-100	100	nA
	$-I_B$	$V_{CM} = 0V$ , $+R_S = 100\Omega$ , $-R_S = 100.1k\Omega$	1	25	-50	50	nA
			2, 3	125, -55	-100	100	nA
Input Offset Current	$I_{IO}$	$V_{CM} = 0V$ , $+R_S = 100.1k\Omega$ , $-R_S = 100.1k\Omega$	1	25	-50	50	nA
			2, 3	125, -55	-100	100	nA
Common Mode Range	+CMR	$V+ = +8V$ , $V- = -22V$	1	25	7	-	V
			2, 3	125, -55	7	-	V
	-CMR	$V+ = +22V$ , $V- = -8V$	1	25	-	-7	V
			2, 3	125, -55	-	-7	V
Large Signal Voltage Gain	$+A_{VOL}$	$V_{OUT} = 0V$ and $+10V$ , $R_L = 1k\Omega$	4	25	114	-	dB
			5, 6	125, -55	108	-	dB
	$-A_{VOL}$	$V_{OUT} = 0V$ and $-10V$ , $R_L = 1k\Omega$	4	25	114	-	dB
			5, 6	125, -55	108	-	dB
Common Mode Rejection Ratio	+CMRR	$\Delta V_{CM} = +2V$ , $V+ = +13V$ , $V- = -17V$ , $V_{OUT} = -2V$	1	25	80	-	dB
			2, 3	125, -55	80	-	dB
	-CMRR	$\Delta V_{CM} = -2V$ , $V+ = +17V$ , $V- = -13V$ , $V_{OUT} = 2V$	1	25	80	-	dB
			2, 3	125, -55	80	-	dB

## HA-2548/883

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Tested at:  $V_{SUPPLY} = \pm 15V$ ,  $R_{LOAD} = 100k\Omega$ ,  $V_{OUT} = 0V$ , Unless Otherwise Specified.

PARAMETERS	SYMBOL	CONDITIONS	GROUP A SUBGROUPS	TEMP. (°C)	MIN	MAX	UNITS
Output Voltage Swing	+V <sub>OUT</sub>	R <sub>L</sub> = 1kΩ	4	25	11	-	V
			5, 6	125, -55	11	-	V
	-V <sub>OUT</sub>	R <sub>L</sub> = 1kΩ	4	25	-	-11	V
			5, 6	125, -55	-	-11	V
Output Current	+I <sub>OUT</sub>	V <sub>OUT</sub> = +10V	4	25	30	-	mA
			5, 6	125, -55	30	-	mA
	-I <sub>OUT</sub>	V <sub>OUT</sub> = -10V	4	25	-	-30	mA
			5, 6	125, -55	-	-30	mA
Quiescent Power Supply Current	+I <sub>CC</sub>	V <sub>OUT</sub> = 0V, I <sub>OUT</sub> = 0mA	1	25	-	18	mA
			2, 3	125, -55	-	18	mA
	-I <sub>CC</sub>	V <sub>OUT</sub> = 0V, I <sub>OUT</sub> = 0mA	1	25	-18	-	mA
			2, 3	125, -55	-18	-	mA
Power Supply Rejection Ratio	+PSRR	$\Delta V_{SUP} = 10V$ , V <sub>+</sub> = +10V, V <sub>-</sub> = -15V, V <sub>+</sub> = +20V, V <sub>-</sub> = -15V	1	25	86	-	dB
			2, 3	125, -55	86	-	dB
	-PSRR	$\Delta V_{SUP} = 10V$ , V <sub>+</sub> = +15V, V <sub>-</sub> = -10V, V <sub>+</sub> = +15V, V <sub>-</sub> = -20V	1	25	86	-	dB
			2, 3	125, -55	86	-	dB

**TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS**

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

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Characterized at:  $V_{SUPPLY} = \pm 15V$ ,  $R_{LOAD} = 1k\Omega$ ,  $C_{LOAD} \leq 10pF$ , Unless Otherwise Specified.

PARAMETERS	SYMBOL	CONDITIONS	NOTES	TEMP. (°C)	MIN	MAX	UNITS
Average Offset Voltage Drift	V <sub>IO</sub> TC	V <sub>CM</sub> = 0V	2	-55 to 125	-	7	μV/°C
Offset Voltage Adjust	V <sub>IO</sub> Adj		2, 6	25	1	-	mV
Input Noise Voltage Density	E <sub>N</sub>	R <sub>S</sub> = 10Ω, f <sub>O</sub> = 1kHz	2	25	-	13.0	nV/√Hz
Input Noise Current Density	I <sub>N</sub>	R <sub>S</sub> = 500Ω, f <sub>O</sub> = 1kHz	2	25	-	1.0	pA/√Hz
Gain Bandwidth Product	GBWP	V <sub>O</sub> = 1.0V, f <sub>O</sub> = 1MHz	2	25	-	130	MHz
			2	-55 to 125	-	110	MHz
Slew Rate	+SR	V <sub>OUT</sub> = -5V to +5V	2	25	80	-	V/μs
			2	-55 to 125	70	-	V/μs
	-SR	V <sub>OUT</sub> = +5V to -5V	2	25	80	-	V/μs
			2	-55 to 125	70	-	V/μs
Full Power Bandwidth	FPBW	V <sub>PEAK</sub> = 10V	2, 3	25	1.11	-	MHz

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)**

Device Characterized at:  $V_{SUPPLY} = \pm 15V$ ,  $R_{LOAD} = 1k\Omega$ ,  $C_{LOAD} \leq 10pF$ , Unless Otherwise Specified.

PARAMETERS	SYMBOL	CONDITIONS	NOTES	TEMP. (°C)	MIN	MAX	UNITS
Minimum Closed Loop Stable Gain	CLSG	$R_L = 1k\Omega$ , $C_L = 10pF$	2	-55 to 125	5	-	V/V
Rise and Fall Time	$t_r$	$V_{OUT} = -100mV$ to $+100mV$	2, 5	25	-	15	ns
			2, 5	-55 to 125	-	20	ns
	$t_f$	$V_{OUT} = +100mV$ to $-100mV$	2, 5	25	-	15	ns
			2, 5	-55 to 125	-	20	ns
Overshoot	+OS	$V_{OUT} = -100mV$ to $+100mV$	2	25	-	30	%
			2	-55 to 125	-	35	%
	-OS	$V_{OUT} = +100mV$ to $-100mV$	2	25	-	30	%
			2	-55 to 125	-	35	%
Settling Time	$t_S$	To 0.01% for a 10V Step	2	25	-	260	ns
Power Consumption	PC	$V_{OUT} = 0V$ , $I_{OUT} = 0mA$	2, 4	-55 to 125	-	540	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  $FPBW = Slew\ Rate / (2\pi V_{PEAK})$ .
- Power Consumption based upon Quiescent Supply Current test maximum. (No load on outputs.)
- Measured between 10% and 90% points.
- Offset adjustment range is  $[V_{IO}(Measured) \pm 1mV]$  minimum referred to output. This test is for functionality only to assure adjustment through 0V.

**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 7), 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.

# HA-2548/883

## Die Characteristics

### DIE DIMENSIONS:

85 mils x 91 mils x 19 mils  
2160 $\mu$ m x 2320 $\mu$ m x 483 $\mu$ m

### METALLIZATION:

Type: Al, 1% Cu  
Thickness: 16k $\text{\AA}$   $\pm$  2k $\text{\AA}$

### GLASSIVATION:

Type: Nitride (Si<sub>3</sub>N<sub>4</sub>) over Silox (SiO<sub>2</sub>, 5% Phos.)  
Silox Thickness: 12k $\text{\AA}$   $\pm$  2k $\text{\AA}$   
Nitride Thickness: 3.5k $\text{\AA}$   $\pm$  1.5k $\text{\AA}$

### WORST CASE CURRENT DENSITY:

3.6 x 10<sup>4</sup> A/cm<sup>2</sup>

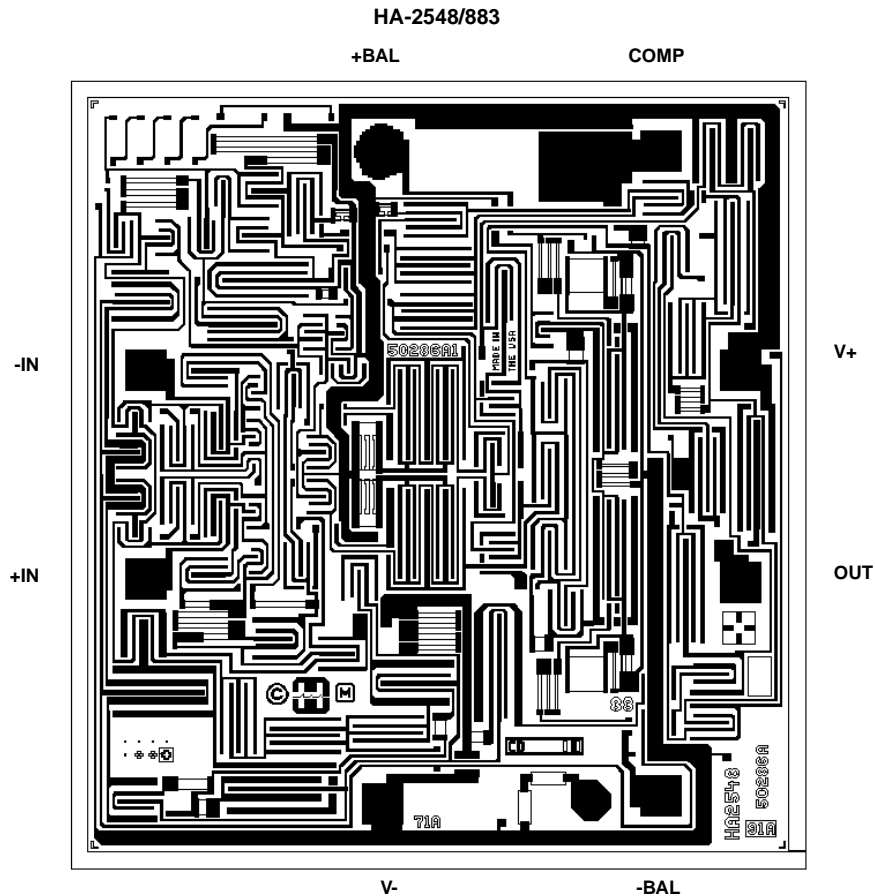
### SUBSTRATE POTENTIAL (Powered Up): V- (Note)

### TRANSISTOR COUNT: 60

### PROCESS: Bipolar, Dielectric Isolation

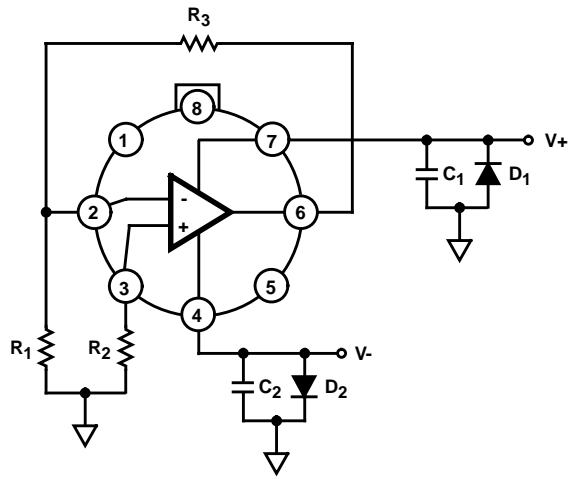
NOTE: The Substrate may be left floating (Insulating Die Mount) or it may be mounted on a conductor at a V- potential.

## Metallization Mask Layout



**Burn-In Circuit**

HA2-2548/883 METAL CAN



NOTES:

$R_1 = 1k\Omega, \pm 5\%, 1/4W$  (Min)

$R_2 = 1k\Omega, \pm 5\%, 1/4W$  (Min)

$R_3 = 10k\Omega, \pm 5\%, 1/4W$  (Min)

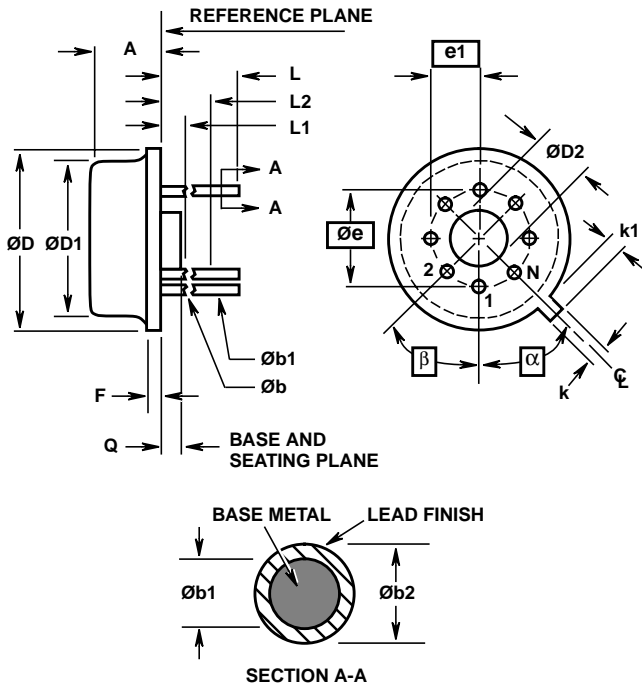
$C_1 = 0.01\mu F$ /Socket or  $0.1\mu F$ /Row

$C_2 = 0.01\mu F$ /Socket or  $0.1\mu F$ /Row

$D_1 = D_2 = 1N4002$  or Equivalent/Board

$|V_+ - V_-| = 31V \pm 1V$

**Metal Can Packages (Can)**



**T8.C MIL-STD-1835 MACY1-X8 (A1)  
8 LEAD METAL CAN PACKAGE**

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN	MAX	MIN	MAX	
A	0.165	0.185	4.19	4.70	-
Øb	0.016	0.019	0.41	0.48	1
Øb1	0.016	0.021	0.41	0.53	1
Øb2	0.016	0.024	0.41	0.61	-
ØD	0.335	0.375	8.51	9.40	-
ØD1	0.305	0.335	7.75	8.51	-
ØD2	0.110	0.160	2.79	4.06	-
e	0.200 BSC		5.08 BSC		-
e1	0.100 BSC		2.54 BSC		-
F	-	0.040	-	1.02	-
k	0.027	0.034	0.69	0.86	-
k1	0.027	0.045	0.69	1.14	2
L	0.500	0.750	12.70	19.05	1
L1	-	0.050	-	1.27	1
L2	0.250	-	6.35	-	1
Q	0.010	0.045	0.25	1.14	-
α	45° BSC		45° BSC		3
β	45° BSC		45° BSC		3
N	8		8		4

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**NOTES:**

- (All leads) Øb applies between L1 and L2. Øb1 applies between L2 and 0.500 from the reference plane. Diameter is uncontrolled in L1 and beyond 0.500 from the reference plane.
- Measured from maximum diameter of the product.
- α is the basic spacing from the centerline of the tab to terminal 1 and β is the basic spacing of each lead or lead position (N - 1 places) from α, looking at the bottom of the package.
- N is the maximum number of terminal positions.
- Dimensioning and tolerancing per ANSI Y14.5M - 1982.
- Controlling dimension: INCH.

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