

July 1994

## Video 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.
- Wide Unity Gain Bandwidth ..... 45MHz (Min)
- High Slew Rate..... 100V/μs (Min)
- Low Supply Current..... 12mA (Max)
- Differential Gain Error ..... 0.04dB (Max)
- Differential Phase Error..... 0.11 Deg. (Max)
- Gain Flatness at 3.58MHz or 4.43MHz ... 0.15dB (Max)
- Fast Settling Time (10V to 0.1%)..... 120ns (Typ)

### Applications

- Video Systems
- Video Test Equipment
- Radar Displays
- Imaging Systems
- Pulse Amplifiers
- Signal Conditioning Circuits
- Data Acquisition Systems

### Description

The HA-2544/883 is a fast, unity gain stable, monolithic op amp designed to meet the needs required for accurate reproduction of video or high speed signals. It offers high voltage gain (3.5kV/V min, 6kV/V typ), wide unity gain bandwidth of 45MHz minimum and phase margin of 65 degrees (open loop). Built from high quality Dielectric Isolation, the HA-2544/883 is another addition to the Harris series of high speed, wideband op amps, and offers true video performance combined with the versatility of an op amp.

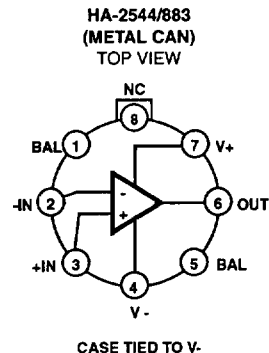
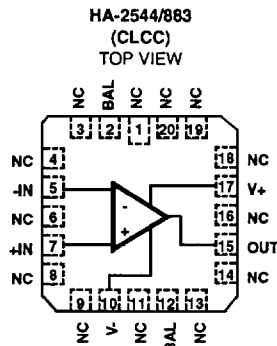
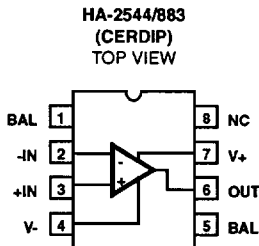
The primary features of the HA-2544/883, include wide bandwidth, 150V/μs (typ) slew rate, < 0.04dB differential gain error, < 0.11 degrees differential phase error and gain flatness of just 0.15dB at 3.58MHz and 4.43MHz, therefore proving to be sufficient for video amplification. High performance and low power requirements are met with a supply current of only 10mA typically and 12mA over the full temperature range.

Uses of the HA-2544/883 range from video test equipment guidance systems, radar displays and other precise imaging systems where stringent gain and phase requirements have previously been met with costly hybrids and discrete circuitry. The HA-2544/883 will also be used in non-video systems requiring high speed signal conditioning such as data acquisition systems, medical electronics, specialized instrumentation and communication systems.

### Ordering Information

PART NUMBER	TEMPERATURE RANGE	PACKAGE
HA2-2544/883	-55°C to +125°C	8 Pin Can
HA4-2544/883	-55°C to +125°C	20 Lead Ceramic LCC
HA7-2544/883	-55°C to +125°C	8 Lead CerDIP

### Pinouts



## Specifications HA-2544/883

### Absolute Maximum Ratings

Voltage Between V+ and V- Terminals	35V
Differential Input Voltage (Note 2)	6V
Voltage at Either Input Terminal	V+ to V-
Peak Output Current (< 10% Duty Cycle)	40mA
Junction Temperature (T <sub>J</sub> )	+175°C
Storage Temperature Range	-65°C to +150°C
ESD Rating	<2000V
Lead Temperature (Soldering 10s)	+300°C

### Thermal Information

Thermal Resistance	$\theta_{JA}$	$\theta_{JC}$
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 <sub>J</sub> ≤ +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	±15V	$R_L \geq 2k\Omega$

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: V<sub>SUPPLY</sub> = ±15V, R<sub>SOURCE</sub> = 10Ω, R<sub>LOAD</sub> = 500kΩ, C<sub>LOAD</sub> ≤ 10pF, V<sub>OUT</sub> = 0V, Unless Otherwise Specified.

PARAMETERS	SYMBOL	CONDITIONS	GROUP A SUBGROUPS	TEMPERATURE	LIMITS		UNITS
					MIN	MAX	
Input Offset Voltage	V <sub>IO</sub>	V <sub>CM</sub> = 0V	1	+25°C	-15	15	mV
			2, 3	+125°C, -55°C	-20	20	mV
Input Bias Current	+I <sub>B</sub>	V <sub>CM</sub> = 0V, +R <sub>S</sub> = 1kΩ, -R <sub>S</sub> = 10Ω	1	+25°C	-15	15	μA
			2, 3	+125°C, -55°C	-20	20	μA
	-I <sub>B</sub>	V <sub>CM</sub> = 0V, +R <sub>S</sub> = 10Ω, -R <sub>S</sub> = 1kΩ	1	+25°C	-15	15	μA
			2, 3	+125°C, -55°C	-20	20	μA
Input Offset Current	I <sub>IO</sub>	V <sub>CM</sub> = 0V, +R <sub>S</sub> = 1kΩ, -R <sub>S</sub> = 1kΩ	1	+25°C	-2	2	μA
			2, 3	+125°C, -55°C	-3	3	μA
Common Mode Range	+CMR	V+ = 5V, V- = -25V	1	+25°C	10	-	V
			2, 3	+125°C, -55°C	10	-	V
	-CMR	V+ = 25V, V- = -5V	1	+25°C	-	-10	V
			2, 3	+125°C, -55°C	-	-10	V
Large Signal Voltage Gain	+A <sub>VOL</sub>	V <sub>OUT</sub> = 0V and +8V, R <sub>L</sub> = 1kΩ	4	+25°C	3.5	-	kV/V
			5, 6	+125°C, -55°C	2.5	-	kV/V
	-A <sub>VOL</sub>	V <sub>OUT</sub> = 0V and -8V, R <sub>L</sub> = 1kΩ	4	+25°C	3.5	-	kV/V
			5, 6	+125°C, -55°C	2.5	-	kV/V
Common Mode Rejection Ratio	+CMRR	ΔV <sub>CM</sub> = +10V, V+ = +5V, V- = -25V, V <sub>OUT</sub> = -10V	1	+25°C	75	-	dB
			2, 3	+125°C, -55°C	75	-	dB
	-CMRR	ΔV <sub>CM</sub> = -10V, V+ = +25V, V- = -5V, V <sub>OUT</sub> = +10V	1	+25°C	75	-	dB
			2, 3	+125°C, -55°C	75	-	dB
Output Voltage Swing	+V <sub>OUT</sub>	R <sub>L</sub> = 1kΩ	1	+25°C	10	-	V
			2, 3	+125°C, -55°C	10	-	V
	-V <sub>OUT</sub>	R <sub>L</sub> = 1kΩ	1	+25°C	-	-10	V
			2, 3	+125°C, -55°C	-	-10	V

## Specifications HA-2544/883

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

Device Tested at:  $V_{SUPPLY} = \pm 15V$ ,  $R_{SOURCE} = 10\Omega$ ,  $R_{LOAD} = 500k\Omega$ ,  $C_{LOAD} \leq 10pF$ ,  $V_{OUT} = 0V$ , Unless Otherwise Specified.

PARAMETERS	SYMBOL	CONDITIONS	GROUP A SUBGROUPS	TEMPERATURE	LIMITS		UNITS
					MIN	MAX	
Output Current	+I <sub>OUT</sub>	V <sub>OUT</sub> = -9V	1	+25°C	25	-	mA
	-I <sub>OUT</sub>	V <sub>OUT</sub> = +9V	1	+25°C	-	-25	mA
Quiescent Power Supply Current	+I <sub>CC</sub>	V <sub>OUT</sub> = 0V, I <sub>OUT</sub> = 0mA	1	+25°C	-	12	mA
			2, 3	+125°C, -55°C	-	12	mA
	-I <sub>CC</sub>	V <sub>OUT</sub> = 0V, I <sub>OUT</sub> = 0mA	1	+25°C	-12	-	mA
			2, 3	+125°C, -55°C	-12	-	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°C	70	-	dB
			2, 3	+125°C, -55°C	70	-	dB
	-PSRR	$\Delta V_{SUP} = 10V$ , V <sub>+</sub> = +15V, V <sub>-</sub> = -10V, V <sub>+</sub> = +15V, V <sub>-</sub> = -20V	1	+25°C	70	-	dB
			2, 3	+125°C, -55°C	70	-	dB
Offset Voltage Adjustment	+V <sub>IOAdj</sub>	Note 1	1	+25°C	V <sub>IO</sub> -1	-	mV
	-V <sub>IOAdj</sub>	Note 1	1	+25°C	V <sub>IO</sub> +1	-	mV

**NOTE:**

- Offset adjustment range is [V<sub>IO</sub>(Measured) ±1mV] minimum referred to output. This test is for functionality only to assure adjustment through 0V.
- To achieve optimum AC performance, the input stage was designed without protective diode clamps. Exceeding the maximum differential input voltage results in reverse breakdown to the base-emitter junction of the input transistors and probable degradation of the input parameters especially V<sub>OS</sub>, I<sub>OS</sub> and Noise.

**TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at:  $V_{SUPPLY} = \pm 15V$ ,  $R_{SOURCE} = 100\Omega$ ,  $R_{LOAD} = 1k\Omega$ ,  $C_{LOAD} = 10pF$ ,  $V_{OUT} = 1V/V$ , Unless Otherwise Specified.

PARAMETERS	SYMBOL	CONDITIONS	GROUP A SUBGROUPS	TEMPERATURE	LIMITS		UNITS
					MIN	MAX	
Slew Rate	+SR	V <sub>OUT</sub> = -3V to +3V	7	+25°C	100	-	V/μs
	-SR	V <sub>OUT</sub> = +3V to -3V	7	+25°C	100	-	V/μs

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS**

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

PARAMETERS	SYMBOL	CONDITIONS	NOTES	TEMPERATURE	LIMITS		UNITS
					MIN	MAX	
Differential Gain	dA <sub>V</sub>	R <sub>S</sub> = 50Ω, R <sub>L</sub> = 1kΩ, f <sub>O</sub> = 3.58MHz and 4.43MHz	1, 5, 6, 8	+25°C	-	0.04	dB
Differential Phase	d∅	R <sub>S</sub> = 50Ω, R <sub>L</sub> = 1kΩ, f <sub>O</sub> = 3.58MHz and 4.43MHz	1, 6, 8	+25°C	-	0.11	Degrees
Unity Gain Bandwidth	UGBW	V <sub>O</sub> = 200mV <sub>RMS</sub> , f at -3dB	1	+25°C	45	-	MHz

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

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

PARAMETERS	SYMBOL	CONDITIONS	NOTES	TEMPERATURE	LIMITS		UNITS
					MIN	MAX	
Gain Flatness	$\Delta A_V$	$V_O = 200mV_{RMS}$ , $f_O = 5MHz$	1, 6	+25°C	-0.15	0.15	dB
		$V_O = 200mV_{RMS}$ , $f_O = 10MHz$	1, 6	+25°C	-0.35	0.35	dB
Full Power Bandwidth	FPBW	$V_{PEAK} = 1V$	1, 2	+25°C	15.9	-	MHz
		$V_{PEAK} = 5V$	1, 2	+25°C	3.2	-	MHz
Minimum Closed Loop Stable Gain	CLSG	$R_L = 1k\Omega$ , $C_L \leq 1pF$	1	-55°C to +125°C	1	-	V/V
Rise and Fall Time	$T_R$	$V_{OUT} = 0V$ to +200mV	1, 4	+25°C	-	15	ns
	$T_F$	$V_{OUT} = 0V$ to -200mV	1, 4	+25°C	-	15	ns
Overshoot	+OS	$V_{OUT} = 0V$ to +200mV	1	+25°C	-	20	%
	-OS	$V_{OUT} = 0V$ to -200mV	1	+25°C	-	20	%
Settling Time	$T_S$	Open Loop	1	+25°C	-	150	%
Output Resistance	$R_{OUT}$	Open Loop	1	+25°C	-	40	$\Omega$
Quiescent Power Consumption	PC	$V_{OUT} = 0V$ , $I_{OUT} = 0mA$	1, 3	-55°C to +125°C	-	360	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  $FPBW = \text{Slew Rate}/(2\pi V_{PEAK})$ .
3. Quiescent Power Consumption based upon Quiescent Supply Current test maximum. (No load on outputs.)
4. Measured between 10% and 90% points.
5.  $A_D(\%) = \left[ \frac{A_D(\text{dB})}{10 \quad 20 \quad -1} \right] \times 100$
6. The video parameter specifications will degrade as the output load resistance decreases.
7. C-L Gain and C-L Delay were less than the resolution of the test equipment used which is 0.1dB and 7ns, respectively.
8. Test signal used is 200mV<sub>RMS</sub> at each frequency on a 0 and 1 volt offset. For adequate test repeatability, a minimum warm-up of 2 minutes is suggested.

**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:**

80 x 64 x 19 mils  $\pm$  1 mils  
 2030 x 1630 x 483  $\mu$ m  $\pm$  25.4  $\mu$ 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:**

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

**SUBSTRATE POTENTIAL (Powered Up): V-**

**TRANSISTOR COUNT: 44**

**PROCESS: Bipolar Dielectric Isolation**

**Metallization Mask Layout**

HA-2544/883

