

## Selectable, Four Channel Video Operational Amplifier

August 1998

### Features

- This Circuit is Processed in Accordance to MIL-STD-883 and is Fully Conformant Under the Provisions of Paragraph 1.2.1.
- Digital Selection of Input Channel
- Unity Gain Stable
- Gain Flatness (to 10MHz) . . . . . 0.12dB (Typ)
- Differential Gain . . . . . 0.03% (Typ)
- Differential Phase. . . . . 0.03 Degrees (Typ)
- Fast Channel Selection . . . . . 100ns (Max)
- Crosstalk Rejection . . . . . 60dB (Typ)

### Applications

- Programmable Gain Amplifier
- Special Effects Processors
- Video Distribution Systems/Multiplexers
- Heads-up/Night Vision Displays
- Radar Video
- Flight Simulators
- IR Imaging

### Ordering Information

| PART NUMBER  | TEMPERATURE RANGE | PACKAGE        |
|--------------|-------------------|----------------|
| HA1-2444/883 | -55°C to +125°C   | 16 Lead CerDIP |

### Description

The HA-2444/883 is a channel-selectable video op amp consisting of four differential inputs, a single-ended output, and digital control circuitry allowing two digital inputs to activate one of the four differential inputs. The HA-2444/883 also includes a high impedance output state allowing the outputs of multiple HA-2444/883s to be wire-OR'd. Functionally, the HA-2444/883 is equivalent to four wideband video op amps and a wideband multiplexer.

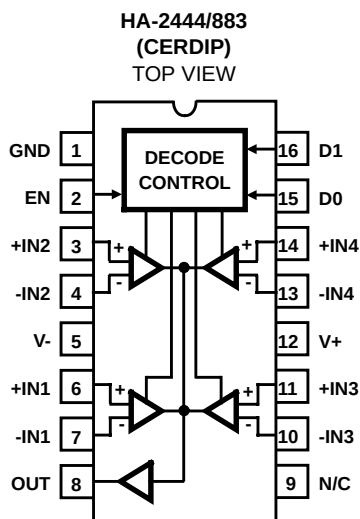
Unlike similar competitor devices, the HA-2444/883 is not restricted to multiplexing. Any op amp configuration can be used with any of the inputs. Signal amplification, addition, integration, and more can be put under digital control with broadcast quality performance.

The key video parameters of the HA-2444/883 have been optimized without compromising DC performance. Gain Flatness, to 10MHz, is only 0.12dB. Differential gain and phase are typically 0.03% and 0.03 degrees, respectively.

Laser trimming allows offset voltages in the 4.0mV range and a unique common current source design assures minimal channel-to-channel mismatch, while maintaining 60dB of crosstalk rejection at 5MHz. Open loop gain of 76dB and low input offset and bias currents enhance the performance of this versatile device.

Uses for the HA-2444/883 include video test equipment, guidance systems, radar displays, and other precise imaging systems where stringent gain and phase requirements have previously required costly hybrids and discrete circuitry. It will also be used for systems requiring high speed signal conditioning, such as data acquisition systems, specialized instrumentation, and communications systems.

### Pinout



### Logic Operation

TRUTH TABLE

| EN | D1 | D0 | SELECTED CHANNEL                           |
|----|----|----|--------------------------------------------|
| H  | L  | L  | 1                                          |
| H  | L  | H  | 2                                          |
| H  | H  | L  | 3                                          |
| H  | H  | H  | 4                                          |
| L  | X  | X  | NONE-OUT is set to a high impedance state. |

L = Low State (0.8V Max.)  
H = High State (2.4V Min.)  
X = Don't Care

# Specifications HA-2444/883

## Absolute Maximum Ratings

Voltage between V+ and V- Terminals . . . . . 35V  
Differential Input Voltage . . . . . 6V  
Voltage at Either Input Terminal . . . . . V+ to V-  
Voltage on Digital Inputs . . . . . GND +7.5V to GND -0.5V  
Peak Output Current ( $\leq 10\%$  Duty Cycle) . . . . . 40mA  
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  $\theta_{JA}$   $\theta_{JC}$   
CerDIP Package . . . . . 82°C/W 27°C/W  
Package Power Dissipation Limit at +75°C for  $T_J \leq +175^\circ\text{C}$   
CerDIP Package . . . . . 1.22W  
Package Power Dissipation Derating Factor Above +75°C  
CerDIP Package . . . . . 12.2mW/°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 . . . . .  $\pm 12\text{V}$  to  $\pm 15\text{V}$   $R_L \geq 1\text{k}\Omega$

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at:  $V_{SUPPLY} = \pm 15\text{V}$ ,  $R_{SOURCE} = 50\Omega$ ,  $R_{LOAD} = 1\text{k}\Omega$ ,  $C_{LOAD} \leq 10\text{pF}$ ,  $V_{OUT} = 0\text{V}$ ,  $V_{IL} = 0.8\text{V}$ ,  $V_{IH} = 2.4\text{V}$ ,  
Unless Otherwise Specified.

| PARAMETERS                                       | SYMBOL      | CONDITIONS                                                                                           | GROUP A<br>SUBGROUP | TEMPERATURE   | LIMITS |     | UNITS         |
|--------------------------------------------------|-------------|------------------------------------------------------------------------------------------------------|---------------------|---------------|--------|-----|---------------|
|                                                  |             |                                                                                                      |                     |               | MIN    | MAX |               |
| Input Offset Voltage                             | $V_{IO}$    | $V_{CM} = 0\text{V}$                                                                                 | 1                   | +25°C         | -7     | 7   | mV            |
|                                                  |             |                                                                                                      | 2, 3                | +125°C, -55°C | -20    | 20  | mV            |
| Channel to Channel<br>Offset Voltage<br>Mismatch | $V_{IODEV}$ | $V_{CM} = 0\text{V}$                                                                                 | 1                   | +25°C         | -      | 5   | mV            |
|                                                  |             |                                                                                                      | 2, 3                | +125°C, -55°C | -      | 12  | mV            |
| Input Bias Current                               | + $I_B$     | $V_{CM} = 0\text{V}$ , $+R_S = 250\Omega$<br>$-R_S = 50\Omega$                                       | 1                   | +25°C         | -15    | 15  | $\mu\text{A}$ |
|                                                  |             |                                                                                                      | 2, 3                | +125°C, -55°C | -25    | 25  | $\mu\text{A}$ |
|                                                  | - $I_B$     | $V_{CM} = 0\text{V}$ , $+R_S = 50\Omega$<br>$-R_S = 250\Omega$                                       | 1                   | +25°C         | -15    | 15  | $\mu\text{A}$ |
|                                                  |             |                                                                                                      | 2, 3                | +125°C, -55°C | -25    | 25  | $\mu\text{A}$ |
| Input Offset Current                             | $I_{IO}$    | $V_{CM} = 0\text{V}$ , $+R_S = 250\Omega$<br>$-R_S = 250\Omega$                                      | 1                   | +25°C         | -4     | 4   | $\mu\text{A}$ |
|                                                  |             |                                                                                                      | 2, 3                | +125°C, -55°C | -8     | 8   | $\mu\text{A}$ |
| Large Signal Voltage<br>Gain                     | + $A_{VOL}$ | $V_{OUT} = 0\text{V}$ and +5V                                                                        | 4                   | +25°C         | 71     | -   | dB            |
|                                                  |             |                                                                                                      | 5, 6                | +125°C, -55°C | 65     | -   | dB            |
|                                                  | - $A_{VOL}$ | $V_{OUT} = 0\text{V}$ and -5V                                                                        | 4                   | +25°C         | 71     | -   | dB            |
|                                                  |             |                                                                                                      | 5, 6                | +125°C, -55°C | 65     | -   | dB            |
| Common Mode<br>Rejection Ratio                   | +CMRR       | $\Delta V_{CM} = +5\text{V}$ ,<br>$V_{OUT} = -5\text{V}$ ,<br>$V+ = 10\text{V}$ , $V- = -20\text{V}$ | 1                   | +25°C         | 68     | -   | dB            |
|                                                  |             |                                                                                                      | 2, 3                | +125°C, -55°C | 68     | -   | dB            |
|                                                  | -CMRR       | $\Delta V_{CM} = -5\text{V}$ ,<br>$V_{OUT} = +5\text{V}$ ,<br>$V+ = 20\text{V}$ , $V- = -10\text{V}$ | 1                   | +25°C         | 68     | -   | dB            |
|                                                  |             |                                                                                                      | 2, 3                | +125°C, -55°C | 68     | -   | dB            |
| Output Voltage Swing                             | + $V_{OUT}$ |                                                                                                      | 1                   | +25°C         | 10     | -   | V             |
|                                                  |             |                                                                                                      | 2, 3                | +125°C, -55°C | 10     | -   | V             |
|                                                  | - $V_{OUT}$ |                                                                                                      | 1                   | +25°C         | -      | -10 | V             |
|                                                  |             |                                                                                                      | 2, 3                | +125°C, -55°C | -      | -10 | V             |
| Output Current                                   | + $I_{OUT}$ | $V_{OUT} = -10\text{V}$<br>$R_{LOAD} = \text{OPEN}$                                                  | 1                   | +25°C         | 25     | -   | mA            |
|                                                  |             |                                                                                                      | 2, 3                | +125°C, -55°C | 25     | -   | mA            |
|                                                  | - $I_{OUT}$ | $V_{OUT} = 10\text{V}$<br>$R_{LOAD} = \text{OPEN}$                                                   | 1                   | +25°C         | -      | -25 | mA            |
|                                                  |             |                                                                                                      | 2, 3                | +125°C, -55°C | -      | -25 | mA            |
| Output Current<br>(Device Disabled)              | +DISAB      | $V_{OUT} = 5\text{V}$ , $V_{EN} = 0.8\text{V}$<br>$R_{LOAD} = \text{OPEN}$                           | 1                   | +25°C         | -      | 860 | $\mu\text{A}$ |
|                                                  |             |                                                                                                      | 2, 3                | +125°C, -55°C | -      | 860 | $\mu\text{A}$ |
|                                                  | -DISAB      | $V_{OUT} = -5\text{V}$ , $V_{EN} = 0.8\text{V}$<br>$R_{LOAD} = \text{OPEN}$                          | 1                   | +25°C         | -      | 860 | $\mu\text{A}$ |
|                                                  |             |                                                                                                      | 2, 3                | +125°C, -55°C | -      | 860 | $\mu\text{A}$ |

## Specifications HA-2444/883

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at:  $V_{\text{SUPPLY}} = \pm 15\text{V}$ ,  $R_{\text{SOURCE}} = 50\Omega$ ,  $R_{\text{LOAD}} = 1\text{k}\Omega$ ,  $C_{\text{LOAD}} \leq 10\text{pF}$ ,  $V_{\text{OUT}} = 0\text{V}$ ,  $V_{\text{IL}} = 0.8\text{V}$ ,  $V_{\text{IH}} = 2.4\text{V}$ , Unless Otherwise Specified. **(Continued)**

| PARAMETERS                             | SYMBOL              | CONDITIONS                                                                                                                               | GROUP A<br>SUBGROUP | TEMPERATURE   | LIMITS |     | UNITS |
|----------------------------------------|---------------------|------------------------------------------------------------------------------------------------------------------------------------------|---------------------|---------------|--------|-----|-------|
|                                        |                     |                                                                                                                                          |                     |               | MIN    | MAX |       |
| Quiescent Power<br>Supply Current      | +I <sub>CC</sub>    | $V_{\text{OUT}} = 0\text{V}$<br>$I_{\text{OUT}} = 0\text{mA}$                                                                            | 1                   | +25°C         | -      | 25  | mA    |
|                                        |                     |                                                                                                                                          | 2, 3                | +125°C, -55°C | -      | 25  | mA    |
|                                        | -I <sub>CC</sub>    | $V_{\text{OUT}} = 0\text{V}$<br>$I_{\text{OUT}} = 0\text{mA}$                                                                            | 1                   | +25°C         | -25    | -   | mA    |
|                                        |                     |                                                                                                                                          | 2, 3                | +125°C, -55°C | -25    | -   | mA    |
| Supply Current<br>(Device Disabled)    | +I <sub>CCDIS</sub> | $V_{\text{OUT}} = 0\text{V}$<br>$V_{\text{EN}} = 0.8\text{V}$                                                                            | 1                   | +25°C         | -      | 10  | mA    |
|                                        |                     |                                                                                                                                          | 2, 3                | +125°C, -55°C | -      | 10  | mA    |
|                                        | -I <sub>CCDIS</sub> | $V_{\text{OUT}} = 0\text{V}$<br>$V_{\text{EN}} = 0.8\text{V}$                                                                            | 1                   | +25°C         | -10    | -   | mA    |
|                                        |                     |                                                                                                                                          | 2, 3                | +125°C, -55°C | -10    | -   | mA    |
| Power Supply<br>Rejection<br>Ratio     | +PSRR               | $\Delta V_{\text{SUPPLY}} = 5\text{V}$ ,<br>$V_{+} = 15\text{V}$ , $V_{-} = -15\text{V}$<br>$V_{+} = 20\text{V}$ , $V_{-} = -15\text{V}$ | 1                   | +25°C         | 65     | -   | dB    |
|                                        |                     |                                                                                                                                          | 2, 3                | +125°C, -55°C | 65     | -   | dB    |
|                                        | -PSRR               | $\Delta V_{\text{SUPPLY}} = 5\text{V}$ ,<br>$V_{+} = 15\text{V}$ , $V_{-} = -15\text{V}$<br>$V_{+} = 15\text{V}$ , $V_{-} = -20\text{V}$ | 1                   | +25°C         | 65     | -   | dB    |
|                                        |                     |                                                                                                                                          | 2, 3                | +125°C, -55°C | 65     | -   | dB    |
| Digital Input Voltages<br>(D0, D1, EN) | V <sub>IL</sub>     |                                                                                                                                          | 1                   | +25°C         | -      | 0.8 | V     |
|                                        |                     |                                                                                                                                          | 2, 3                | +125°C, -55°C | -      | 0.8 | V     |
|                                        | V <sub>IH</sub>     |                                                                                                                                          | 1                   | +25°C         | 2.4    | -   | V     |
|                                        |                     |                                                                                                                                          | 2, 3                | +125°C, -55°C | 2.4    | -   | V     |
| Input Current (D0, D1)                 | DX <sub>IL</sub>    | V <sub>IL</sub> = 0V                                                                                                                     | 1                   | +25°C         | -      | 1   | mA    |
|                                        |                     |                                                                                                                                          | 2, 3                | +125°C, -55°C | -      | 1   | mA    |
|                                        | DX <sub>IH</sub>    | V <sub>IH</sub> = 5V                                                                                                                     | 1                   | +25°C         | -      | 1.2 | μA    |
|                                        |                     |                                                                                                                                          | 2, 3                | +125°C, -55°C | -      | 1.2 | μA    |
| Input Current (EN)                     | EN <sub>IL</sub>    | V <sub>IL</sub> = 0V                                                                                                                     | 1                   | +25°C         | -      | 50  | μA    |
|                                        |                     |                                                                                                                                          | 2, 3                | +125°C, -55°C | -      | 50  | μA    |
|                                        | EN <sub>IH</sub>    | V <sub>IH</sub> = 5V                                                                                                                     | 1                   | +25°C         | -      | 1.2 | μA    |
|                                        |                     |                                                                                                                                          | 2, 3                | +125°C, -55°C | -      | 1.2 | μA    |

**TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at:  $V_{\text{SUPPLY}} = \pm 15\text{V}$ ,  $R_{\text{SOURCE}} = 50\Omega$ ,  $R_{\text{LOAD}} = 1\text{k}\Omega$ ,  $C_{\text{LOAD}} \leq 10\text{pF}$ ,  $A_{\text{VCL}} = +1\text{V/V}$ ,  $V_{\text{IL}} = 0.8\text{V}$ ,  $V_{\text{IH}} = 2.4\text{V}$ , Unless Otherwise Specified.

| PARAMETERS             | SYMBOL | CONDITIONS                              | GROUP A<br>SUBGROUP | TEMPERATURE   | LIMITS |     | UNITS |
|------------------------|--------|-----------------------------------------|---------------------|---------------|--------|-----|-------|
|                        |        |                                         |                     |               | MIN    | MAX |       |
| Slew Rate              | +SR    | $V_{\text{OUT}} = -5\text{V}$ to +5V    | 7                   | +25°C         | 120    | -   | V/μs  |
|                        |        |                                         | 8                   | +125°C, -55°C | 120    | -   | V/μs  |
|                        | -SR    | $V_{\text{OUT}} = +5\text{V}$ to -5V    | 7                   | +25°C         | 120    | -   | V/μs  |
|                        |        |                                         | 8                   | +125°C, -55°C | 120    | -   | V/μs  |
| Channel Select<br>Time | CHSE   | Note 1<br>$V_{\text{EN}} = 2.4\text{V}$ | 9, 10               | +25°C, +125°C | -      | 100 | ns    |
|                        |        |                                         | 11                  | -55°C         | -      | 125 | ns    |
| Output Enable<br>Time  | CHEN   | Note 2                                  | 9                   | +25°C         | -      | 100 | ns    |
|                        |        |                                         | 10, 11              | +125°C, -55°C | -      | 100 | ns    |

**NOTES:**

1. Measured for all channel combinations. Channel Select time is the delay in switching from channel X to channel Y. Channel Y input set to +5V, all other channels set to 0V. Select time is measured from the 50% point of the critical digital select input to the 50% point on the output.
2. Channel 1 selected with the input at 5V. All other channels set to 0V. Enable input switched from 0.8V to 2.4V. Enable time is measured from the 50% point of the EN input to the 50% point on the output.

## Specifications HA-2444/883

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Characterized at:  $V_{SUPPLY} = \pm 15V$ ,  $R_{SOURCE} = 50\Omega$ ,  $R_{LOAD} = 1k\Omega$ ,  $C_L \leq 10pF$ ,  $A_{VCL} = 1V/V$ ,  $V_{IL} = 0.8V$ ,  $V_{IH} = 2.4V$ , Unless Otherwise Specified.

| PARAMETERS                      | SYMBOL | CONDITIONS                       | NOTES | TEMPERATURE                 | LIMITS |     | UNITS |
|---------------------------------|--------|----------------------------------|-------|-----------------------------|--------|-----|-------|
|                                 |        |                                  |       |                             | MIN    | MAX |       |
| Rise Time                       | $T_R$  | $V_{OUT} = 0V$ to $+200mV$       | 1, 4  | $+25^\circ C$               | -      | 11  | ns    |
|                                 |        |                                  | 1, 4  | $-55^\circ C, +125^\circ C$ | -      | 12  | ns    |
| Fall Time                       | $T_F$  | $V_{OUT} = 0V$ to $-200mV$       | 1, 4  | $+25^\circ C$               | -      | 11  | ns    |
|                                 |        |                                  | 1, 4  | $-55^\circ C, +125^\circ C$ | -      | 12  | ns    |
| Overshoot                       | +OS    | $V_{OUT} = 0V$ to $+200mV$       | 1     | $+25^\circ C$               | -      | 15  | %     |
|                                 |        |                                  | 1     | $-55^\circ C, +125^\circ C$ | -      | 30  | %     |
|                                 | -OS    | $V_{OUT} = 0V$ to $-200mV$       | 1     | $+25^\circ C$               | -      | 15  | %     |
|                                 |        |                                  | 1     | $-55^\circ C, +125^\circ C$ | -      | 30  | %     |
| Full Power Bandwidth            | FPBW   | $V_{PEAK} = 5V$                  | 1, 2  | $+25^\circ C$               | 3.8    | -   | MHz   |
|                                 |        |                                  | 1, 2  | $-55^\circ C, +125^\circ C$ | 3.8    | -   | MHz   |
| Minimum Closed Loop Stable Gain | CLSG   |                                  | 1     | $+25^\circ C$               | 1      | -   | V/V   |
|                                 |        |                                  | 1     | $-55^\circ C, +125^\circ C$ | 1      | -   | V/V   |
| Quiescent Power Consumption     | PC     | $V_{OUT} = 0V$ , $I_{OUT} = 0mA$ | 1, 3  | $+25^\circ C$               | -      | 750 | mW    |
|                                 |        |                                  | 1, 3  | $-55^\circ C, +125^\circ C$ | -      | 750 | 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  $FPBW = \text{Slew Rate} / (2\pi V_{PEAK})$ .
- Power Consumption based upon Quiescent Supply Current test maximum. (No load on outputs.)
- Measured between 10% and 90% points.

**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, 8, 9, 10, 11 |
| Group A Test Requirements                   | 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11          |
| Groups C and D Endpoints                    | 1                                          |

**NOTE:**

- PDA applies to Subgroup 1 only.

## Die Characteristics

### DIE DIMENSIONS:

74mils x 103mils x 19mils  $\pm$  1mil  
 1880 $\mu$ m x 2620 $\mu$ m x 483 $\mu$ m  $\pm$  25.4 $\mu$ m

### METALLIZATION:

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

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

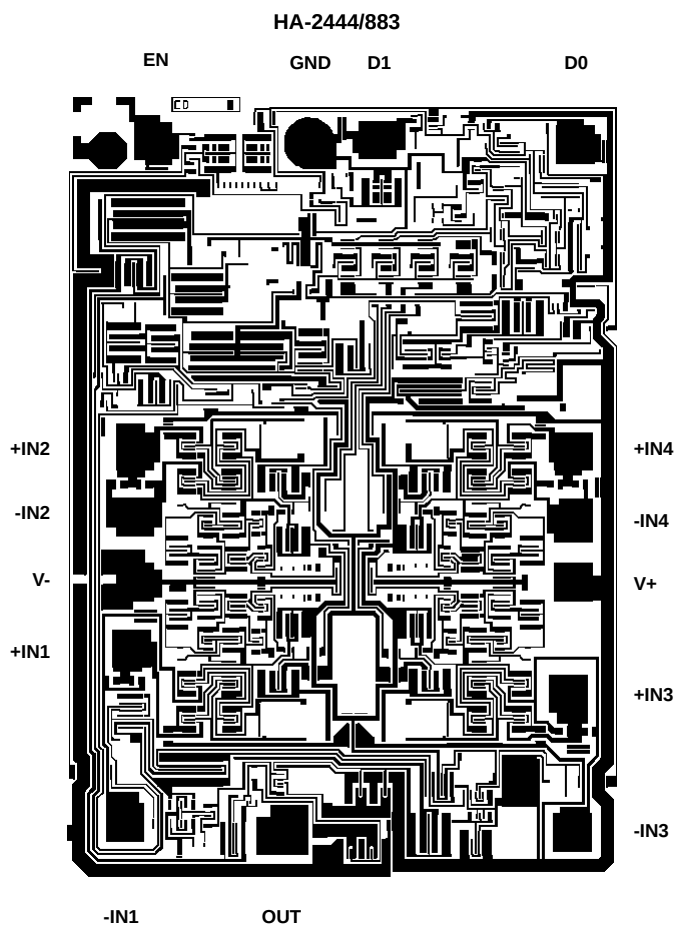
### GLASSIVATION:

Type: Nitride over Silox  
 Silox Thickness: 12k $\text{\AA}$   $\pm$  2k $\text{\AA}$   
 Nitride Thickness: 3.5k $\text{\AA}$   $\pm$  1.5k $\text{\AA}$

### TRANSISTOR COUNT: 129

### PROCESS: Bipolar Dielectric Isolation

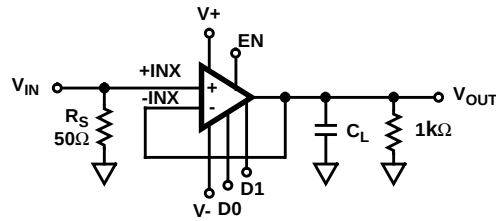
## Metallization Mask Layout



## Test Waveforms

SIMPLIFIED TEST CIRCUIT FOR LARGE AND SMALL SIGNAL PULSE RESPONSE (Applies to Tables 2 and 3)

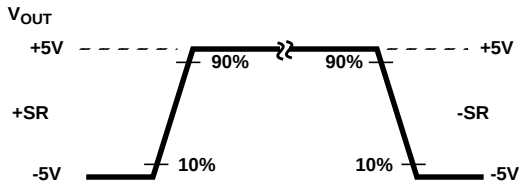
$A_V = +1$  TEST CIRCUIT



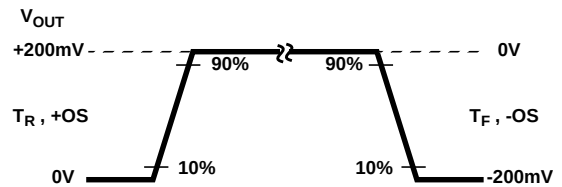
NOTE:

1.  $V_S = \pm 15V$ ,  $A_V = +1$ ,  $C_L \leq 10pF$
2. All 4 Channels Tested
3. D0 and D1 = 2.4V or 0.8V to Select Proper Channel
4. EN = 2.4V

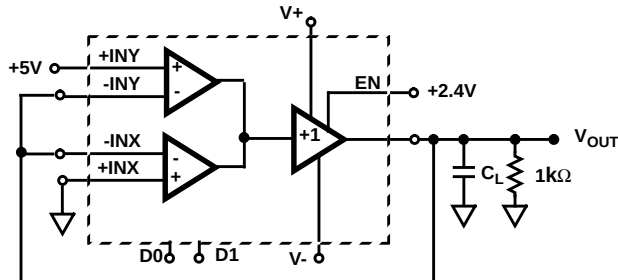
LARGE SIGNAL WAVEFORM



SMALL SIGNAL WAVEFORM



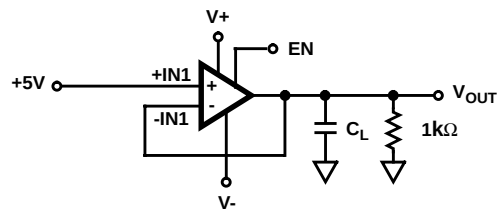
SIMPLIFIED TEST CIRCUIT FOR CHANNEL SELECT TIMES



NOTE:

1.  $V_S = \pm 15V$ ,  $A_V = +1$  (all channels),  $C_L \leq 10pF$
2. All Channel Combinations Tested

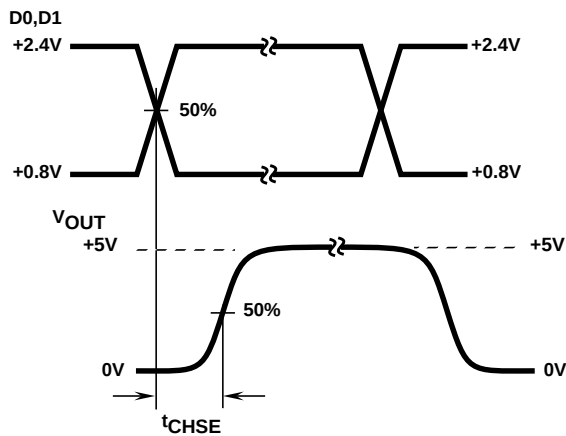
SIMPLIFIED TEST CIRCUIT FOR OUTPUT ENABLE TIMES



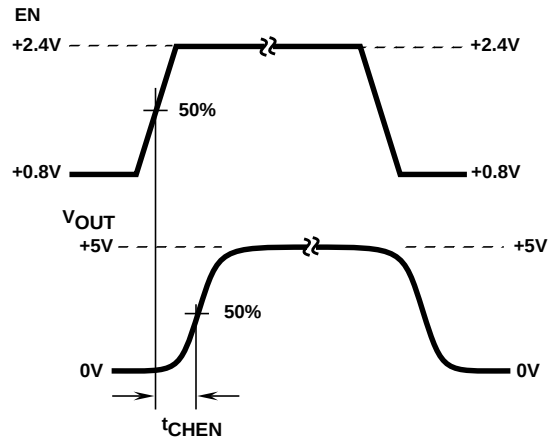
NOTE:

1.  $V_S = \pm 15V$ ,  $A_V = +1$ ,  $C_L \leq 10pF$
2. D0 = D1 = 0.8V, +IN2 = +IN3 = +IN4 = 0V

CHANNEL SELECT TIME SWITCHING WAVEFORMS



OUTPUT ENABLE TIME SWITCHING WAVEFORMS



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