

## Wideband, Fast Settling, Unity Gain Stable, Operational Amplifier

July 1994

### Features

- This Circuit is Processed in Accordance to MIL-STD-883 and is Fully Conformant Under the Provisions of Paragraph 1.2.1.
- Unity Gain Bandwidth ..... 40MHz (Min)
- High Slew Rate..... 200V/ $\mu$ s (Min)  
250V/ $\mu$ s (Typ)
- Low Offset Voltage..... 2mV (Max)
- Fast Settling Time (0.1%) ..... 90ns (Typ)
- Power Bandwidth..... 3MHz (Min)  
4MHz (Typ)
- Output Voltage Swing .....  $\pm 10$ V (Min)
- Unity Gain Stability
- Monolithic Bipolar Dielectric Isolation Construction

### Applications

- Pulse and Video Amplifiers
- Wideband Amplifiers
- High Speed Sample and Hold Circuits
- Fast, Precise D/A Converters
- High Speed A/D Input Buffer

### Description

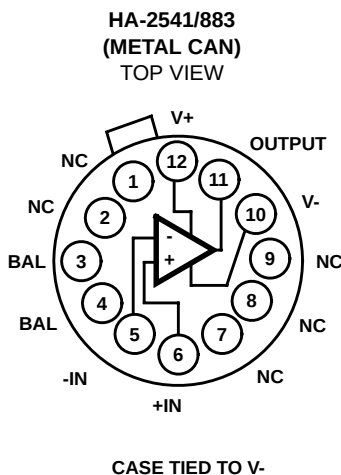
The HA-2541/883 is the first unity gain stable monolithic operational amplifier to achieve 40MHz unity gain bandwidth. A major addition to the Intersil series of high speed, wideband op amps, the HA-2541/883 is designed for video and pulse applications requiring stable amplifier response at low closed loop gains.

The uniqueness of the HA-2541/883 is that its slew rate and bandwidth characteristics are specified at unity gain. Historically, high slew rate, wide bandwidth and unity gain stability have been incompatible features for a monolithic operational amplifier. But features such as 250V/ $\mu$ s slew rate and 40MHz unity gain bandwidth clearly show that this is not the case for the HA-2541/883. These features, along with 90ns settling time to 0.1%, make this product an excellent choice for high speed data acquisition systems.

### Ordering Information

| PART NUMBER  | TEMPERATURE RANGE | PACKAGE    |
|--------------|-------------------|------------|
| HA2-2541/883 | -55°C to +125°C   | 12 Pin Can |

### Pinout



# Specifications HA-2541/883

## Absolute Maximum Ratings

Voltage Between V+ and V- Terminals . . . . . 35V  
Differential Input Voltage . . . . . 6V  
Voltage at Either Input Terminal . . . . . V+ to V-  
Peak Output Current (< 10% Duty Cycle) . . . . . 50mA  
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  $\theta_{JA}$   $\theta_{JC}$   
Metal Can Package . . . . . 65°C/W 34°C/W  
Package Power Dissipation Limit at +75°C for T<sub>J</sub> ≤ +175°C  
Metal Can Package . . . . . 1.54W  
Package Power Dissipation Derating Factor Above +75°C  
Metal Can Package . . . . . 15.4mW/°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<sub>INCM</sub> ≤ 1/2 (V+ - V-)  
Operating Supply Voltage . . . . . ±12V to ±15V R<sub>L</sub> ≥ 1kΩ

**TABLE 1. DC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at: V<sub>SUPPLY</sub> = ±15V, R<sub>SOURCE</sub> = 100Ω, R<sub>LOAD</sub> = 100kΩ, V<sub>OUT</sub> = 0V, Unless Otherwise Specified.

| PARAMETERS                  | SYMBOL            | CONDITIONS                                                                   | GROUP A<br>SUBGROUPS | TEMPERATURE   | LIMITS |     | UNITS |
|-----------------------------|-------------------|------------------------------------------------------------------------------|----------------------|---------------|--------|-----|-------|
|                             |                   |                                                                              |                      |               | MIN    | MAX |       |
| Input Offset Voltage        | V <sub>IO</sub>   | V <sub>CM</sub> = 0V                                                         | 1                    | +25°C         | -2     | 2   | mV    |
|                             |                   |                                                                              | 2, 3                 | +125°C, -55°C | -6     | 6   | mV    |
| Input Bias Current          | +I <sub>B</sub>   | V <sub>CM</sub> = 0V,<br>+R <sub>S</sub> = 1.1kΩ,<br>-R <sub>S</sub> = 100Ω  | 1                    | +25°C         | -35    | 35  | μA    |
|                             |                   |                                                                              | 2, 3                 | +125°C, -55°C | -50    | 50  | μA    |
|                             | -I <sub>B</sub>   | V <sub>CM</sub> = 0V,<br>+R <sub>S</sub> = 100Ω,<br>-R <sub>S</sub> = 1.1kΩ  | 1                    | +25°C         | -35    | 35  | μA    |
|                             |                   |                                                                              | 2, 3                 | +125°C, -55°C | -50    | 50  | μA    |
| Input Offset Current        | I <sub>IO</sub>   | V <sub>CM</sub> = 0V,<br>+R <sub>S</sub> = 1.1kΩ,<br>-R <sub>S</sub> = 1.1kΩ | 1                    | +25°C         | -7     | 7   | μA    |
|                             |                   |                                                                              | 2, 3                 | +125°C, -55°C | -9     | 9   | 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 +10V,<br>R <sub>L</sub> = 1kΩ                      | 4                    | +25°C         | 10     | -   | kV/V  |
|                             |                   |                                                                              | 5, 6                 | +125°C, -55°C | 5      | -   | kV/V  |
|                             | -A <sub>VOL</sub> | V <sub>OUT</sub> = 0V and -10V,<br>R <sub>L</sub> = 1kΩ                      | 4                    | +25°C         | 10     | -   | kV/V  |
|                             |                   |                                                                              | 5, 6                 | +125°C, -55°C | 5      | -   | kV/V  |
| Common Mode Rejection Ratio | +CMRR             | ΔV <sub>CM</sub> = +10V,<br>V+ = +5V, V- = -25V,<br>V <sub>OUT</sub> = -10V  | 1                    | +25°C         | 70     | -   | dB    |
|                             |                   |                                                                              | 2, 3                 | +125°C, -55°C | 70     | -   | dB    |
|                             | -CMRR             | ΔV <sub>CM</sub> = -10V,<br>V+ = +25V, V- = -5V,<br>V <sub>OUT</sub> = +10V  | 1                    | +25°C         | 70     | -   | dB    |
|                             |                   |                                                                              | 2, 3                 | +125°C, -55°C | 70     | -   | 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-2541/883

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

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

| PARAMETERS                        | SYMBOL       | CONDITIONS                                                                              | GROUP A<br>SUBGROUPS | TEMPERATURE   | LIMITS     |     | UNITS |
|-----------------------------------|--------------|-----------------------------------------------------------------------------------------|----------------------|---------------|------------|-----|-------|
|                                   |              |                                                                                         |                      |               | MIN        | MAX |       |
| Output Current                    | $+I_{OUT}$   | $V_{OUT} = -10V$                                                                        | 1                    | +25°C         | 10         | -   | mA    |
|                                   |              |                                                                                         | 1, 3                 | +125°C, -55°C | 10         | -   | mA    |
|                                   | $-I_{OUT}$   | $V_{OUT} = +10V$                                                                        | 1                    | +25°C         | -          | -10 | mA    |
|                                   |              |                                                                                         | 1, 3                 | +125°C, -55°C | -          | -10 | mA    |
| Quiescent Power<br>Supply Current | $+I_{CC}$    | $V_{OUT} = 0V$ , $I_{OUT} = 0mA$                                                        | 1                    | +25°C         | -          | 39  | mA    |
|                                   |              |                                                                                         | 2, 3                 | +125°C, -55°C | -          | 39  | mA    |
|                                   | $-I_{CC}$    | $V_{OUT} = 0V$ , $I_{OUT} = 0mA$                                                        | 1                    | +25°C         | -39        | -   | mA    |
|                                   |              |                                                                                         | 2, 3                 | +125°C, -55°C | -39        | -   | mA    |
| Power Supply<br>Rejection Ratio   | +PSRR        | $\Delta V_{SUP} = 10V$ ,<br>$V_+ = +5V$ , $V_- = -15V$ ,<br>$V_+ = +15V$ , $V_- = -15V$ | 1                    | +25°C         | 70         | -   | dB    |
|                                   |              |                                                                                         | 2, 3                 | +125°C, -55°C | 70         | -   | dB    |
|                                   | -PSRR        | $\Delta V_{SUP} = 10V$ ,<br>$V_+ = +15V$ , $V_- = -5V$ ,<br>$V_+ = +15V$ , $V_- = -15V$ | 1                    | +25°C         | 70         | -   | dB    |
|                                   |              |                                                                                         | 2, 3                 | +125°C, -55°C | 70         | -   | dB    |
| Offset Voltage<br>Adjustment      | $+V_{IOAdj}$ | Note 1                                                                                  | 1                    | +25°C         | $V_{IO}-1$ | -   | mV    |
|                                   | $-V_{IOAdj}$ | Note 1                                                                                  | 1                    | +25°C         | $V_{IO}+1$ | -   | mV    |

NOTE:

- Offset adjustment range is  $[V_{IO}(\text{Measured}) \pm 1mV]$  minimum referred to output. This test is for functionality only to assure adjustment through 0V.

**TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Table 2 Intentionally Left Blank. See A.C. Specifications in Table 3

**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 Input Resistance      | $R_{IN}$ | $V_{CM} = 0V$                   | 1     | +25°C           | 40     | -   | k $\Omega$ |
| Unity Gain Bandwidth               | UGBW     | $V_O = 90mV$                    | 1     | +25°C           | 40     | -   | MHz        |
| Slew Rate                          | +SR      | $V_{OUT} = -3V$ to +3V          | 1     | +25°C           | 200    | -   | V/ $\mu s$ |
|                                    | -SR      | $V_{OUT} = +3V$ to -3V          | 1     | +25°C           | 200    | -   | V/ $\mu s$ |
| Full Power Bandwidth               | FPBW     | $V_{PEAK} = 10V$                | 1, 2  | +25°C           | 3      | -   | MHz        |
| Minimum Closed Loop<br>Stable Gain | CLSG     | $R_L = 1k\Omega$ , $C_L = 10pF$ | 1     | -55°C to +125°C | 1      | -   | V/V        |
| Rise and Fall Time                 | $T_R$    | $V_{OUT} = 0V$ to +200mV        | 1, 4  | +25°C           | -      | 20  | ns         |
|                                    | $T_F$    | $V_{OUT} = 0V$ to -200mV        | 1, 4  | +25°C           | -      | 20  | ns         |

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

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

| PARAMETERS                  | SYMBOL           | CONDITIONS                                                   | NOTES | TEMPERATURE     | LIMITS |      | UNITS    |
|-----------------------------|------------------|--------------------------------------------------------------|-------|-----------------|--------|------|----------|
|                             |                  |                                                              |       |                 | MIN    | MAX  |          |
| Overshoot                   | +OS              | $V_{\text{OUT}} = 0\text{V to } +200\text{mV}$               | 1     | +25°C           | -      | 50   | %        |
|                             | -OS              | $V_{\text{OUT}} = 0\text{V to } -200\text{mV}$               | 1     | +25°C           | -      | 50   | %        |
| Output Resistance           | $R_{\text{OUT}}$ | Open Loop                                                    | 1     | +25°C           | -      | 25   | $\Omega$ |
| Quiescent Power Consumption | PC               | $V_{\text{OUT}} = 0\text{V}$ , $I_{\text{OUT}} = 0\text{mA}$ | 1, 3  | -55°C to +125°C | -      | 1.17 | W        |

**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  $\text{FPBW} = \text{Slew Rate}/(2\pi V_{\text{PEAK}})$ .
- Quiescent 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 TABLE 1)   |
|---------------------------------------------|---------------------------|
| 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:

80 x 90 x 19 mils  $\pm$  1 mils

2020 x 2280 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:

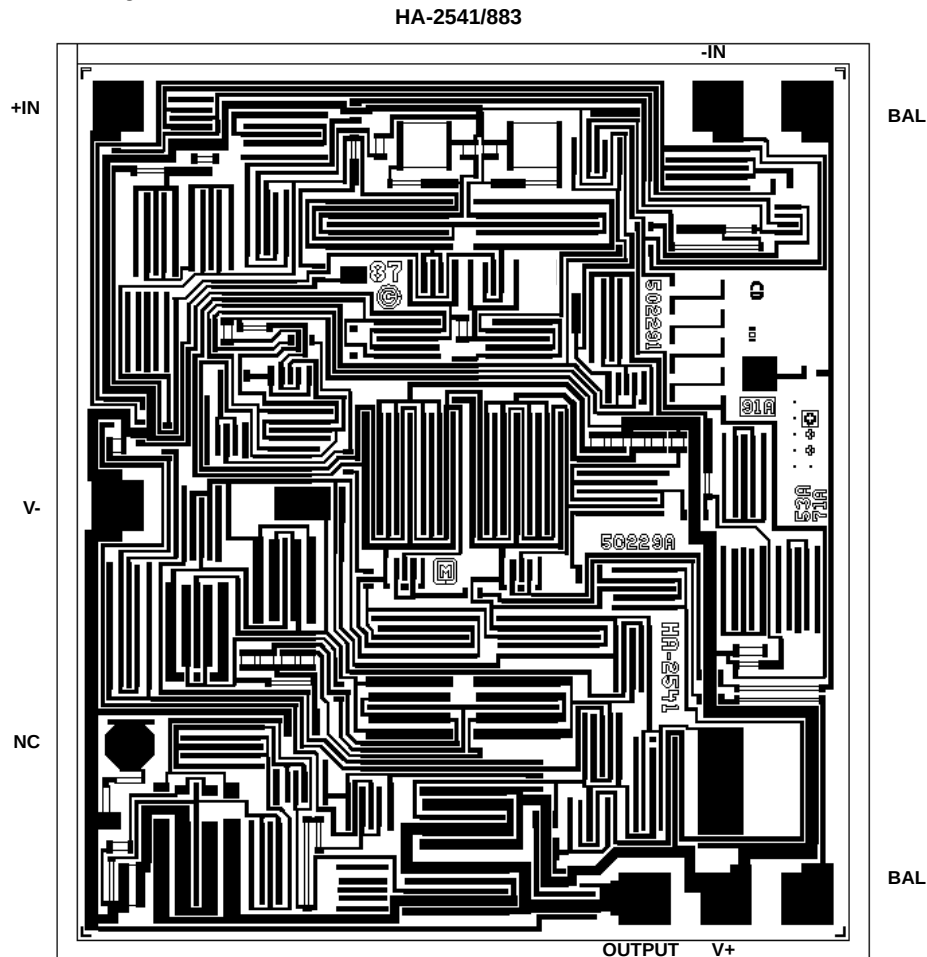
5.3 x 10<sup>4</sup> A/cm<sup>2</sup>

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

### TRANSISTOR COUNT: 41

### PROCESS: Bipolar Dielectric Isolation

## Metallization Mask Layout



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