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## Wideband, High Impedance Operational Amplifier

October 2004

### Features

- This Circuit is Processed in Accordance to MIL-STD-883 and is Fully Conformant Under the Provisions of Paragraph 1.2.1.
- High Input Impedance ..... **40MΩ (Min)**  
**500MΩ (Typ)**
- High Slew Rate..... **4V/μs (Min)**  
**7V/μs (Typ)**
- Low Input Bias Current ..... **25nA (Max)**  
**1nA (Typ)**
- Low Input Offset Current..... **5mV (Max)**
- Wide Unity Gain Bandwidth ..... **12MHz (Typ)**
- Output Short Circuit Protection

### Applications

- Video Amplifier
- Pulse Amplifier
- High-Q Active Filters
- High Speed Comparators
- Low Distortion Oscillators

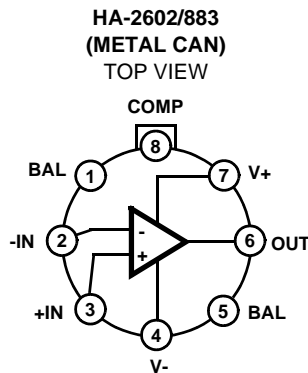
### Description

The HA-2602/883 is an internally compensated bipolar operational amplifier that features very high input impedance coupled with wideband AC performance. The high resistance of the input stage is complemented by low offset voltage (5mV max at +25°C) and low bias and offset current (25nA max at +25°C) to facilitate accurate signal processing. Offset voltage can be reduced further by means of an external nulling potentiometer. The 4V/μs minimum slew rate at +25°C and the minimum open loop gain of 80kV/V at +25°C enables the HA-2602/883 to perform high gain amplification of fast, wideband signals. These dynamic characteristics, coupled with fast settling times, make these amplifiers ideally suited to pulse amplification designs as well as high frequency or video applications. The frequency response of the amplifier can be tailored to exact design requirements by means of an external bandwidth control capacitor. Other high performance designs such as high gain, low distortion audio amplifiers, high-Q and wideband active filters and high speed comparators, are excellent uses of this part.

### Part Number Information

| PART NUMBER  | TEMPERATURE RANGE | PACKAGE   |
|--------------|-------------------|-----------|
| HA2-2602/883 | -55°C to +125°C   | 8 Pin Can |

### Pinout



**Absolute Maximum Ratings**

Voltage Between V+ and V- Terminals ..... 40V  
 Differential Input Voltage ..... 12V  
 Voltage at Either Input Terminal ..... V+ to V-  
 Peak Output Current ..... Full Short Circuit Protection  
 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 ..... 160°C/W 75°C/W  
 Package Power Dissipation Limit at +75°C for T<sub>J</sub> ≤ +175°C  
 Metal Can Package ..... 625mW  
 Package Power Dissipation Derating Factor Above +75°C  
 Metal Can Package ..... 6.3mW/°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.

NOTE:

1.  $\theta_{JA}$  is measured with the component mounted on a low effective thermal conductivity test board in free air. See Tech Brief TB379 for details.

**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> = 100Ω, R<sub>LOAD</sub> = 500kΩ, V<sub>OUT</sub> = 0V, Unless Otherwise Specified.

| PARAMETERS                  | SYMBOL            | CONDITIONS   | GROUP A SUBGROUPS | TEMPERATURE   | HA-2602/883 |     | UNITS |
|-----------------------------|-------------------|--|-------------------|---------------|-------------|-----|-------|
|                             |                   |  |                   |               | MIN         | MAX |       |
| Input Offset Voltage        | V <sub>IO</sub>   | V <sub>CM</sub> = 0V   | 1                 | +25°C         | -5          | 5   | mV    |
|                             |                   |  | 2, 3              | +125°C, -55°C | -7          | 7   | mV    |
| Input Bias Current          | +I <sub>B</sub>   | V <sub>CM</sub> = 0V, +R <sub>S</sub> = 100kΩ, -R <sub>S</sub> = 100Ω  | 1                 | +25°C         | -25         | 25  | nA    |
|                             |                   |  | 2, 3              | +125°C, -55°C | -60         | 60  | nA    |
|                             | -I <sub>B</sub>   | V <sub>CM</sub> = 0V, +R <sub>S</sub> = 100Ω, -R <sub>S</sub> = 100kΩ  | 1                 | +25°C         | -25         | 25  | nA    |
|                             |                   |  | 2, 3              | +125°C, -55°C | -60         | 60  | nA    |
| Input Offset Current        | I <sub>IO</sub>   | V <sub>CM</sub> = 0V, +R <sub>S</sub> = 100kΩ, -R <sub>S</sub> = 100kΩ | 1                 | +25°C         | -25         | 25  | nA    |
|                             |                   |  | 2, 3              | +125°C, -55°C | -60         | 60  | nA    |
| Common Mode Range           | +CMR              | V+ = +4V, V- = -26V  | 1                 | +25°C         | 11          | -   | V     |
|                             |                   |  | 2, 3              | +125°C, -55°C | 11          | -   | V     |
|                             | -CMR              | V+ = +26V, V- = -4V  | 1                 | +25°C         | -           | -11 | V     |
|                             |                   |  | 2, 3              | +125°C, -55°C | -           | -11 | V     |
| Large Signal Voltage Gain   | +A <sub>VOL</sub> | V <sub>OUT</sub> = 0V and +10V, R <sub>L</sub> = 2kΩ                   | 4                 | +25°C         | 80          | -   | kV/V  |
|                             |                   |  | 5, 6              | +125°C, -55°C | 60          | -   | kV/V  |
|                             | -A <sub>VOL</sub> | V <sub>OUT</sub> = 0V and -10V, R <sub>L</sub> = 2kΩ                   | 4                 | +25°C         | 80          | -   | kV/V  |
|                             |                   |  | 5, 6              | +125°C, -55°C | 60          | -   | kV/V  |
| Common Mode Rejection Ratio | +CMRR             | ΔV <sub>CM</sub> = +10V, V+ = +5V, V- = -25V, V <sub>OUT</sub> = -10V  | 1                 | +25°C         | 74          | -   | dB    |
|                             |                   |  | 2, 3              | +125°C, -55°C | 74          | -   | dB    |
|                             | -CMRR             | ΔV <sub>CM</sub> = -10V, V+ = +25V, V- = -5V, V <sub>OUT</sub> = +10V  | 1                 | +25°C         | 74          | -   | dB    |
|                             |                   |  | 2, 3              | +125°C, -55°C | 74          | -   | dB    |
| Output Voltage Swing        | +V <sub>OUT</sub> | R <sub>L</sub> = 2kΩ   | 4                 | +25°C         | 10          | -   | V     |
|                             |                   |  | 5, 6              | +125°C, -55°C | 10          | -   | V     |
|                             | -V <sub>OUT</sub> | R <sub>L</sub> = 2kΩ   | 4                 | +25°C         | -           | -10 | V     |
|                             |                   |  | 5, 6              | +125°C, -55°C | -           | -10 | V     |

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

Device Tested at:  $V_{SUPPLY} = \pm 15V$ ,  $R_{SOURCE} = 100\Omega$ ,  $R_{LOAD} = 500k\Omega$ ,  $V_{OUT} = 0V$ , Unless Otherwise Specified.

| PARAMETERS                        | SYMBOL              | CONDITIONS  | GROUP A<br>SUBGROUPS | TEMPERATURE   | HA-2602/883        |      | UNITS |
|-----------------------------------|---------------------|---|----------------------|---------------|--------------------|------|-------|
|                                   |                     |   |                      |               | MIN                | MAX  |       |
| Output Current                    | +I <sub>OUT</sub>   | V <sub>OUT</sub> = -10V   | 4                    | +25°C         | 10                 | -    | mA    |
|                                   |                     |   | 5, 6                 | +125°C, -55°C | 7.5                | -    | mA    |
|                                   | -I <sub>OUT</sub>   | V <sub>OUT</sub> = +10V   | 4                    | +25°C         | -                  | -10  | mA    |
|                                   |                     |   | 5, 6                 | +125°C, -55°C | -                  | -7.5 | mA    |
| Quiescent Power<br>Supply Current | +I <sub>CC</sub>    | V <sub>OUT</sub> = 0V, I <sub>OUT</sub> = 0mA                             | 1                    | +25°C         | -                  | 3.7  | mA    |
|                                   |                     |   | 2, 3                 | +125°C, -55°C | -                  | 4.0  | mA    |
|                                   | -I <sub>CC</sub>    | V <sub>OUT</sub> = 0V, I <sub>OUT</sub> = 0mA                             | 1                    | +25°C         | -3.7               | -    | mA    |
|                                   |                     |   | 2, 3                 | +125°C, -55°C | -4.0               | -    | mA    |
| Power Supply<br>Rejection Ratio   | +PSRR               | $\Delta V_{SUP} = \pm 5V$ , V+ = +10V, V- = -15V,<br>V+ = +20V, V- = -15V | 1                    | +25°C         | 74                 | -    | dB    |
|                                   |                     |   | 2, 3                 | +125°C, -55°C | 74                 | -    | dB    |
|                                   | -PSRR               | $\Delta V_{SUP} = \pm 5V$ , V+ = +15V, V- = -10V,<br>V+ = +15V, V- = -20V | 1                    | +25°C         | 74                 | -    | dB    |
|                                   |                     |   | 2, 3                 | +125°C, -55°C | 74                 | -    | dB    |
| Offset Voltage<br>Adjustment      | +V <sub>IOAdj</sub> | Note 1  | 1                    | +25°C         | V <sub>IO</sub> -1 | -    | mV    |
|                                   |                     |   | 2, 3                 | +125°C, -55°C | V <sub>IO</sub> -1 | -    | mV    |
|                                   | -V <sub>IOAdj</sub> | Note 1  | 1                    | +25°C         | V <sub>IO</sub> +1 | -    | mV    |
|                                   |                     |   | 2, 3                 | +125°C, -55°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.

**TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at:  $V_{SUPPLY} = \pm 15V$ ,  $R_{SOURCE} = 50\Omega$ ,  $R_{LOAD} = 2k\Omega$ ,  $C_{LOAD} = 50pF$ ,  $A_{VCL} = +1V/V$ , Unless Otherwise Specified.

| PARAMETERS            | SYMBOL         | CONDITIONS   | GROUP A<br>SUBGROUPS | TEMPERATURE   | HA-2602/883 |     | UNITS |
|-----------------------|----------------|--|----------------------|---------------|-------------|-----|-------|
|                       |                |  |                      |               | MIN         | MAX |       |
| Slew Rate             | +SR            | V <sub>OUT</sub> = -5V to +5V                              | 7                    | +25°C         | 4           | -   | V/μs  |
|                       |                |  | 8A, 8B               | +125°C, -55°C | 3           | -   | V/μs  |
|                       | -SR            | V <sub>OUT</sub> = +5V to -5V                              | 7                    | +25°C         | 4           | -   | V/μs  |
|                       |                |  | 8A, 8B               | +125°C, -55°C | 3           | -   | V/μs  |
| Rise and Fall<br>Time | T <sub>R</sub> | V <sub>OUT</sub> = 0 to +200mV, 10% ≤ T <sub>R</sub> ≤ 90% | 7                    | +25°C         | -           | 60  | ns    |
|                       |                |  | 8A, 8B               | +125°C, -55°C | -           | 70  | ns    |
|                       | T <sub>F</sub> | V <sub>OUT</sub> = 0 to -200mV, 10% ≤ T <sub>F</sub> ≤ 90% | 7                    | +25°C         | -           | 60  | ns    |
|                       |                |  | 8A, 8B               | +125°C, -55°C | -           | 70  | ns    |

## HA-2602/883

**TABLE 2. AC ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Tested at:  $V_{SUPPLY} = \pm 15V$ ,  $R_{SOURCE} = 50\Omega$ ,  $R_{LOAD} = 2k\Omega$ ,  $C_{LOAD} = 50pF$ ,  $A_{VCL} = +1V/V$ , Unless Otherwise Specified.

| PARAMETERS | SYMBOL | CONDITIONS                | GROUP A SUBGROUPS | TEMPERATURE   | HA-2602/883 |     | UNITS |
|------------|--------|---------------------------|-------------------|---------------|-------------|-----|-------|
|            |        |                           |                   |               | MIN         | MAX |       |
| Overshoot  | +OS    | $V_{OUT} = 0$ to $+200mV$ | 7                 | +25°C         | -           | 40  | %     |
|            |        |                           | 8A, 8B            | +125°C, -55°C | -           | 50  | %     |
|            | -OS    | $V_{OUT} = 0$ to $-200mV$ | 7                 | +25°C         | -           | 40  | %     |
|            |        |                           | 8A, 8B            | +125°C, -55°C | -           | 50  | %     |

**TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS**

Device Characterized at:  $V_{SUPPLY} = \pm 15V$ ,  $R_{LOAD} = 2k\Omega$ ,  $C_{LOAD} = 50pF$ , Unless Otherwise Specified.

| PARAMETERS                      | SYMBOL           | CONDITIONS                         | NOTES | TEMPERATURE     | HA-2602/883 |     | UNITS |
|---------------------------------|------------------|------------------------------------|-------|-----------------|-------------|-----|-------|
|                                 |                  |                                    |       |                 | MIN         | MAX |       |
| Differential Input Resistance   | $R_{IN}$         | $V_{CM} = 0V$                      | 1     | +25°C           | 40          | -   | MΩ    |
| Full Power Bandwidth            | FPBW             | $V_{PEAK} = 10V$                   | 1, 2  | +25°C           | 50          | -   | kHz   |
| Minimum Closed Loop Stable Gain | CLSG             | $R_L = 2k\Omega$ , $C_L = 50pF$    | 1     | -55°C to +125°C | 1           | -   | V/V   |
| Output Short Circuit Current    | +I <sub>SC</sub> | $V_{OUT} = 1V$ , $R_L = 10\Omega$  | 1     | +25°C           | -           | 50  | mA    |
|                                 |                  |                                    | 1     | +125°C          | -           | 45  | mA    |
|                                 |                  |                                    | 1     | -55°C           | -           | 60  | mA    |
|                                 | -I <sub>SC</sub> | $V_{OUT} = -1V$ , $R_L = 10\Omega$ | 1     | +25°C           | -50         | -   | mA    |
|                                 |                  |                                    | 1     | +125°C          | -45         | -   | mA    |
|                                 |                  |                                    | 1     | -55°C           | -60         | -   | mA    |
| Quiescent Power Consumption     | PC               | $V_{OUT} = 0V$ , $I_{OUT} = 0mA$   | 1, 3  | -55°C to +125°C | -           | 120 | 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, 7, 8A, 8B |
| Group A Test Requirements                   | 1, 2, 3, 4, 5, 6, 7, 8A, 8B          |
| Groups C and D Endpoints                    | 1                                    |

**NOTE:**

- PDA applies to Subgroup 1 only.

# HA-2602/883

## Die Characteristics

### DIE DIMENSIONS:

69 x 56 x 19 mils  $\pm$  1 mils  
1750 x 1420 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:

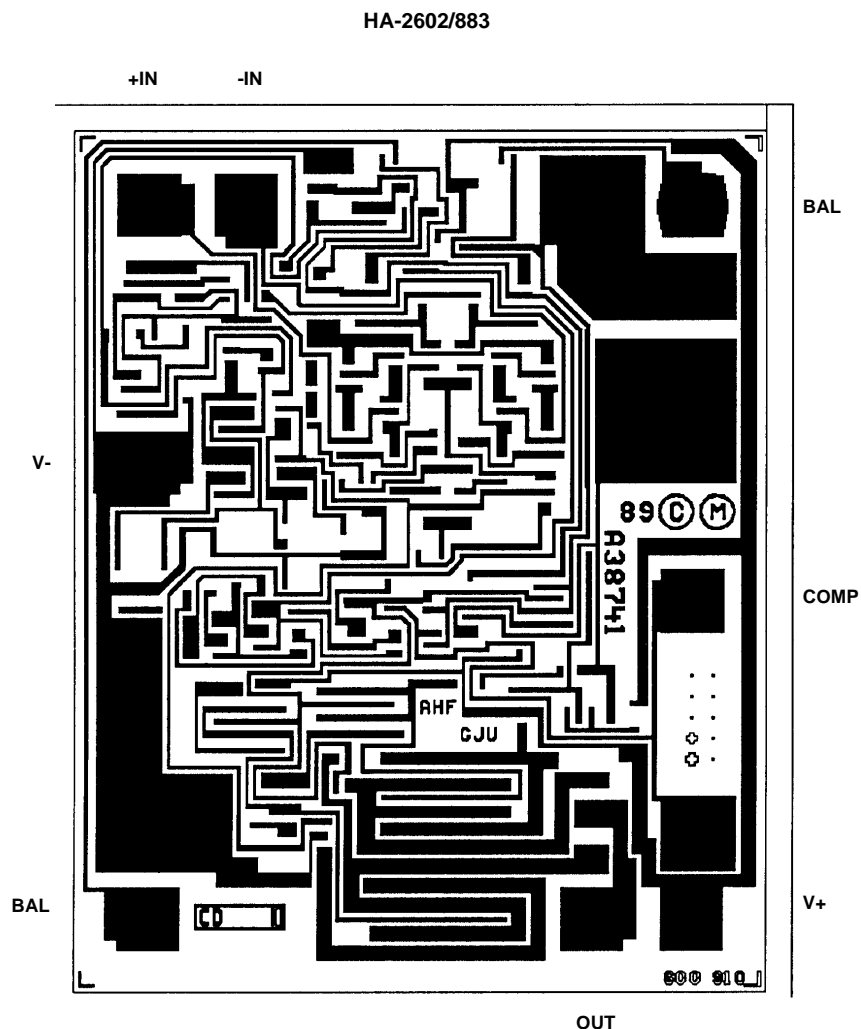
3.9 x 10<sup>4</sup> A/cm<sup>2</sup>

**SUBSTRATE POTENTIAL (Powered Up):** Unbiased

### TRANSISTOR COUNT:

HA-2602/883: 140

## Metallization Mask Layout



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