HARRIS SEMICONDUCTOR

# HA-2500, HA-2502, HA-2505

## 12MHz, High Input Impedance, Operational Amplifiers

November 1996

### Features

- **Slew Rate . . . . . 30V/μs**
- **Fast Settling . . . . . 330ns**
- **Full Power Bandwidth . . . . . 500kHz**
- **Gain Bandwidth . . . . . 12MHz**
- **High Input Impedance . . . . . 50MΩ**
- **Low Offset Current . . . . . 10nA**
- **Internally Compensated For Unity Gain Stability**

### Applications

- **Data Acquisition Systems**
- **RF Amplifiers**
- **Video Amplifiers**
- **Signal Generators**

### Ordering Information

| PART NUMBER | TEMP RANGE ($^{o}$C) | PACKAGE | PKG. NO. |
|---|---|---|---|
| HA2-2500-2 | -55 to 125 | 8 Pin Metal Can | T8.C |
| HA2-2502-2 | -55 to 125 | 8 Pin Metal Can | T8.C |
| HA2-2505-5 | 0 to 75 | 8 Pin Metal Can | T8.C |
| HA3-2505-5 | 0 to 75 | 8 Ld PDIP | E8.3 |
| HA7-2500-2 | -55 to 125 | 8 Ld CERDIP | F8.3A |
| HA7-2505-5 | 0 to 75 | 8 Ld CERDIP | F8.3A |

### Description

HA-2500, HA-2502, HA-2505 comprises a series of operational amplifiers whose designs are optimized to deliver excellent slew rate, bandwidth, and settling time specifications. The outstanding dynamic features of this internally compensated device are complemented with low offset voltage and offset current.

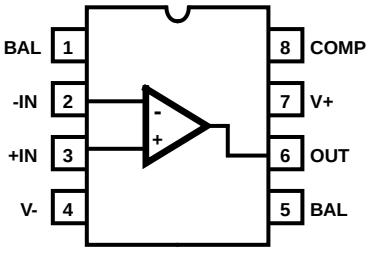
These dielectrically isolated amplifiers are ideally suited for applications such as data acquisition, RF, video, and pulse conditioning circuits. Slew rates of ±30V/μs and 330ns (0.1%) settling time make these devices excellent components in fast, accurate data acquisition and pulse amplification designs. 12MHz small signal bandwidth and 500kHz power bandwidth make these devices well suited to RF and video applications. With 2mV typical offset voltage plus offset trim capability and 10nA offset current, HA-2500, HA-2502, HA-2505 are particularly useful components in signal conditioning designs.

The gain and offset voltage figures of the HA-2500 series are optimized by internal component value changes while the similar design of the HA-2510 series is maximized for slew rate.

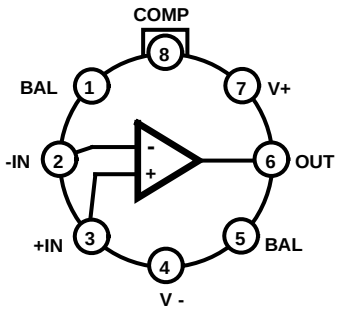
MIL-STD-883 product and data sheets are available upon request.

### Pinouts

**HA-2500/02 (CERDIP)**
**HA-2505 (PDIP, CDIP)**
TOP VIEW




**HA-2500/02/05**
**(METAL CAN)**
TOP VIEW




CAUTION: These devices are sensitive to electrostatic discharge. Users should follow proper IC Handling Procedures.



File Number **2890.2**

## Absolute Maximum Ratings

Supply Voltage Between V+ and V- Terminals . . . . . 40V
Differential Input Voltage. . . . . 15V
Peak Output Current. . . . . 50mA

## Operating Conditions

Temperature Range
HA-2500/2502-2 . . . . . $-55^oC$ to $125^oC$
HA-2505-5. . . . . $0^oC$ to $75^oC$

## Thermal Information

| Thermal Resistance (Typical, Note 1) | $\theta_{JA}$ ($^oC/W$) | $\theta_{JC}$ ($^oC/W$) |
|---|---|---|
| Metal Can Package | 165 | 80 |
| PDIP Package | 96 | N/A |
| CERDIP Package | 135 | 50 |

Maximum Junction Temperature (Hermetic Package) . . . . . $175^oC$
Maximum Junction Temperature (Plastic Package) . . . . . $150^oC$
Maximum Storage Temperature Range . . . . . $-65^oC$ to $150^oC$
Maximum Lead Temperature (Soldering 10s) . . . . . $300^oC$

*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.

## Electrical Specifications $V_S = \pm15V$

| PARAMETER | TEMP ($^oC$) | HA-2500-2 | | | HA-2502-2 | | | HA-2505-5 | | | UNITS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | |
| **INPUT CHARACTERISTICS** | | | | | | | | | | | |
| Offset Voltage | 25 | - | 2 | 5 | - | 4 | 8 | - | 4 | 8 | mV |
| | Full | - | - | 8 | - | - | 10 | - | - | 10 | mV |
| Offset Voltage Average Drift | Full | - | 20 | - | - | 20 | - | - | 20 | - | $\mu V/^oC$ |
| Bias Current | 25 | - | 100 | 200 | - | 125 | 250 | - | 125 | 250 | nA |
| | Full | - | - | 400 | - | - | 500 | - | - | 500 | nA |
| Offset Current | 25 | - | 10 | 25 | - | 20 | 50 | - | 20 | 50 | nA |
| | Full | - | - | 50 | - | - | 100 | - | - | 100 | nA |
| Input Resistance (Note 2) | 25 | 25 | 50 | - | 20 | 50 | - | 20 | 50 | - | MΩ |
| Common Mode Range | Full | ±10 | - | - | ±10 | - | - | ±10 | - | - | V |
| **TRANSFER CHARACTERISTICS** | | | | | | | | | | | |
| Large Signal Voltage Gain (Notes 3, 6) | 25 | 20 | 30 | - | 15 | 25 | - | 15 | 25 | - | kV/V |
| | Full | 15 | - | - | 10 | - | - | 10 | - | - | kV/V |
| Common Mode Rejection Ratio (Note 4) | Full | 80 | 90 | - | 74 | 90 | - | 74 | 90 | - | dB |
| Gain Bandwidth Product (Note 5) | 25 | - | 12 | - | - | 12 | - | - | 12 | - | MHz |
| **OUTPUT CHARACTERISTICS** | | | | | | | | | | | |
| Output Voltage Swing (Note 3) | Full | ±10 | ±12 | - | ±10 | ±12 | - | ±10 | ±12 | - | V |
| Output Current (Note 6) | 25 | ±10 | ±20 | - | ±10 | ±20 | - | ±10 | ±20 | - | mA |
| Full Power Bandwidth (Notes 6, 11) | 25 | 350 | 500 | - | 300 | 500 | - | 300 | 500 | - | kHz |
| **TRANSIENT RESPONSE** | | | | | | | | | | | |
| Rise Time (Notes 3, 7, 8, 9) | 25 | - | 25 | 50 | - | 25 | 50 | - | 25 | 50 | ns |
| Overshoot (Notes 3, 7, 8, 9) | 25 | - | 25 | 40 | - | 25 | 50 | - | 25 | 50 | % |
| Slew Rate (Notes 3, 7, 9, 12) | 25 | ±25 | ±30 | - | ±20 | ±30 | - | ±20 | ±30 | - | V/µs |
| Settling Time to 0.1% (Notes 3, 7, 9, 12) | 25 | - | 0.33 | - | - | 0.33 | - | - | 0.33 | - | µs |

## Electrical Specifications $V_S = \pm15V$ (Continued)

| PARAMETER | TEMP ($^oC$) | HA-2500-2 | | | HA-2502-2 | | | HA-2505-5 | | | UNITS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | MIN | TYP | MAX | MIN | TYP | MAX | MIN | TYP | MAX | |
| **POWER SUPPLY CHARACTERISTICS** | | | | | | | | | | | |
| Supply Current | 25 | - | 4 | 6 | - | 4 | 6 | - | 4 | 6 | mA |
| PSRR (Note 10) | Full | 80 | 90 | - | 74 | 90 | - | 74 | 90 | - | dB |

NOTES:

2. This parameter value is based on design calculations.
3. $R_L = 2k\Omega$.
4. $V_{CM} = \pm10V$.
5. $A_V > 10$.
6. $V_O = \pm10V$.
7. $C_L = 50pF$.
8. $V_O = \pm200mV$.
9. See Transient Response Test Circuits and Waveforms.
10. $\Delta V = \pm5V$.
11. Full Power Bandwidth guaranteed based on slew rate measurement using: FPBW = Slew Rate/$2\pi V_{PEAK}$.
12. $V_{OUT} = \pm5V$.

## Test Circuits and Waveforms

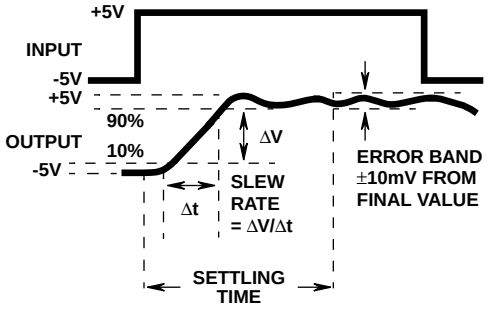
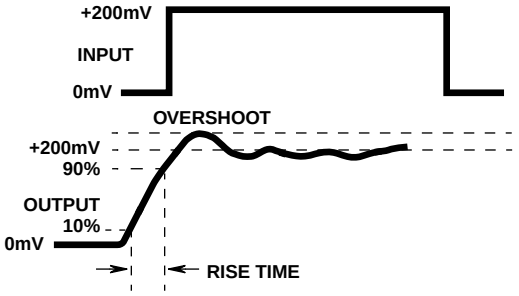
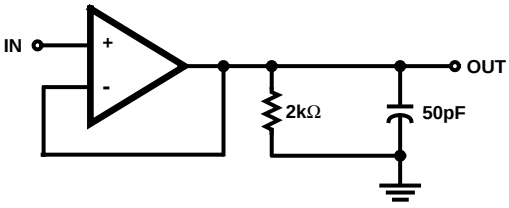



**FIGURE 1. SLEW RATE AND SETTLING TIME**



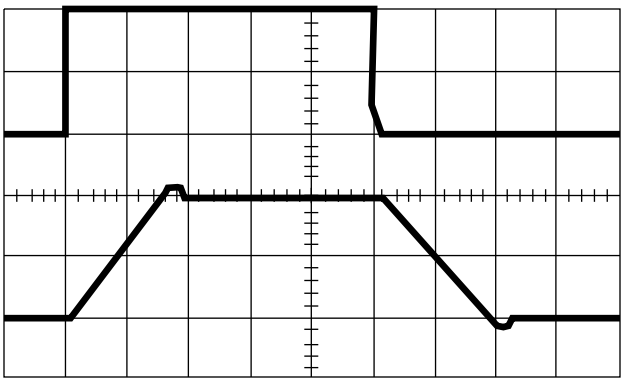

NOTE: Measured on both positive and negative transitions from 0V to +200mv and 0V to -200mV at the output.

**FIGURE 2. TRANSIENT RESPONSE**




NOTE: Measured on both positive and negative transitions from 0V to +200mv and 0V to -200mV at the output.

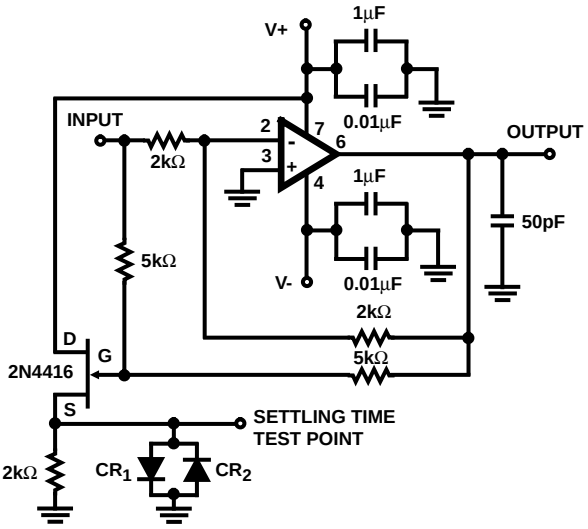
**FIGURE 3. SLEW RATE AND TRANSIENT RESPONSE**



$R_L = 2k\Omega$, $C_L = 50pF$ Vertical = 5V/Div.
Upper Trace: Input Horizontal = 200ns/Div.
Lower Trace: Output $T_A = 25^oC$, $V_S = \pm15V$

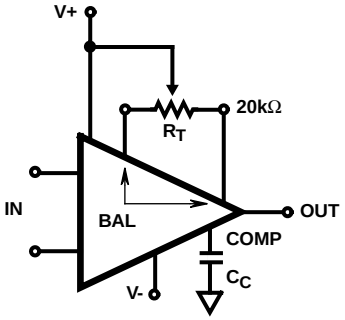
**FIGURE 4. VOLTAGE FOLLOWER PULSE RESPONSE**

## Test Circuits and Waveforms (Continued)




13. $A_V$ = -1.
14. Feedback and Summing Resistor Ratios should be 0.1% matched.
15. Clipping Diodes $CR_1$ and $CR_2$ are optional. HP5082-2810 recommended.

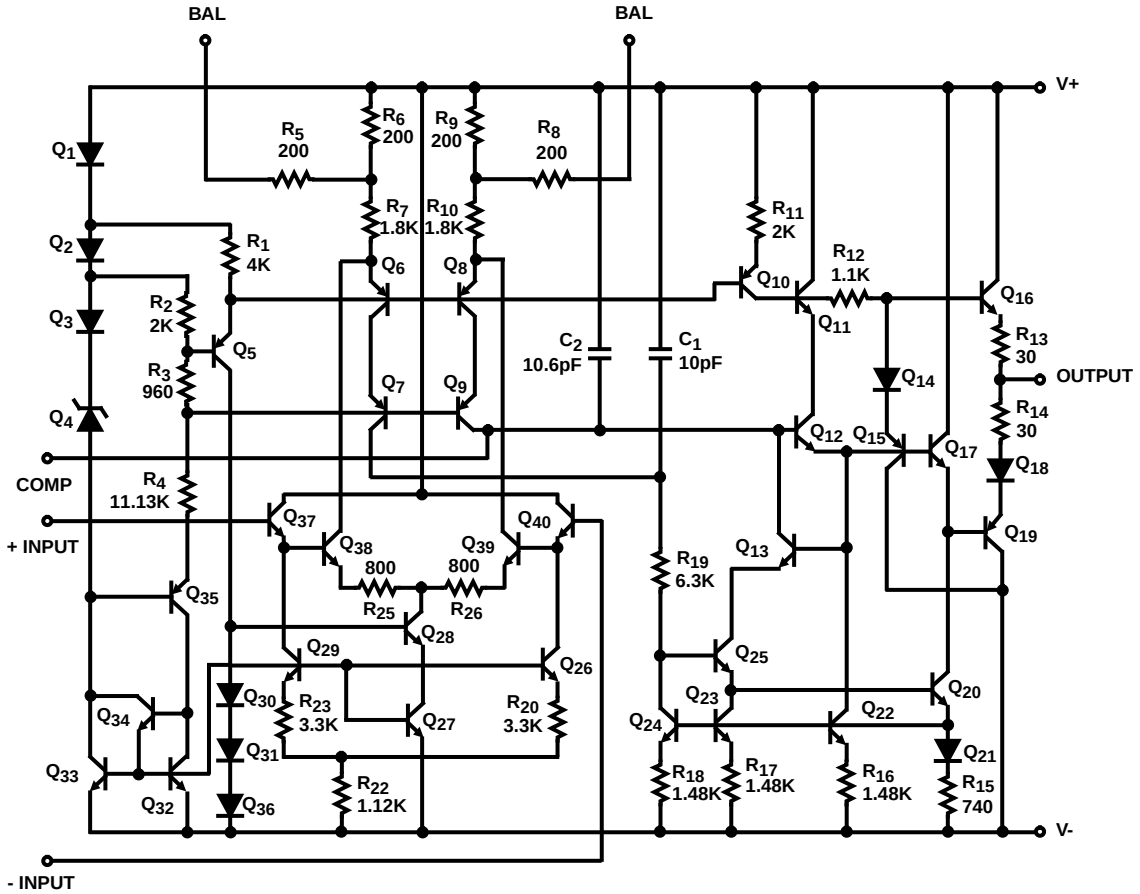
**FIGURE 5. SETTLING TIME TEST CIRCUIT**




NOTE: Tested offset adjustment range is $|V_{OS} + 1mV|$ minimum referred to output. Typical ranges are ±6mV with $R_T$ = 20kΩ.

**FIGURE 6. SUGGESTED $V_{OS}$ ADJUSTMENT AND COMPENSATION HOOK UP**

## Schematic



## Typical Performance Curves $V_S = \pm15V$, $T_A = 25^oC$, Unless Otherwise Specified

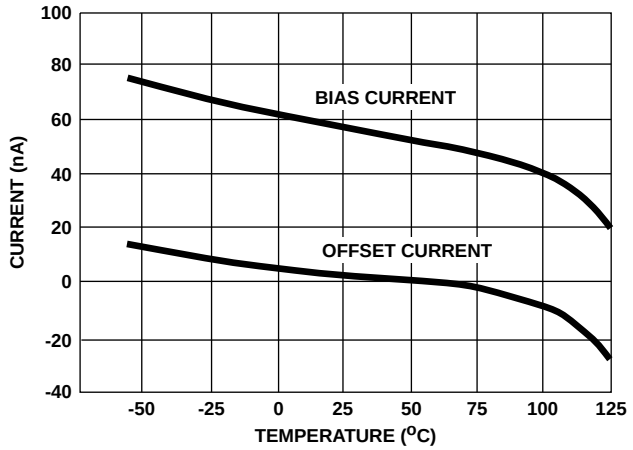



FIGURE 7. INPUT BIAS AND OFFSET CURRENT vs TEMPERATURE

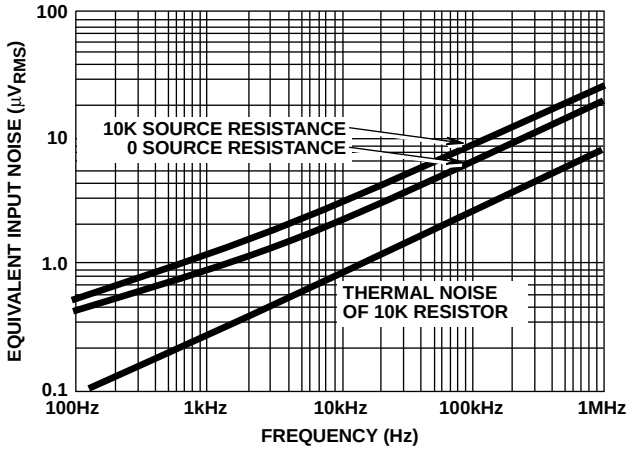



FIGURE 8. EQUIVALENT INPUT NOISE vs BANDWIDTH (WITH 10Hz HIGH PASS FILTER)

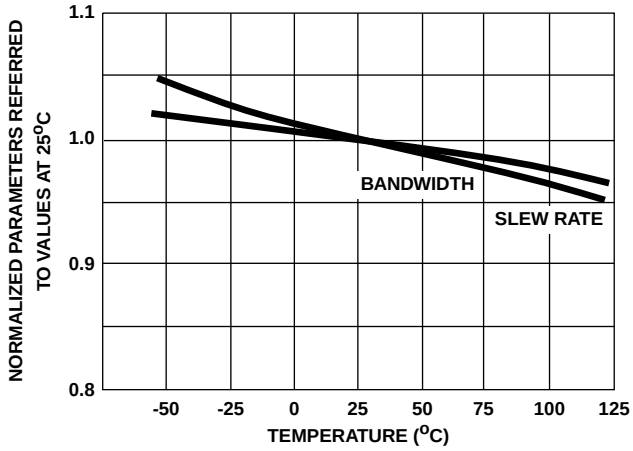



FIGURE 9. NORMALIZED AC PARAMETERS vs TEMPERATURE

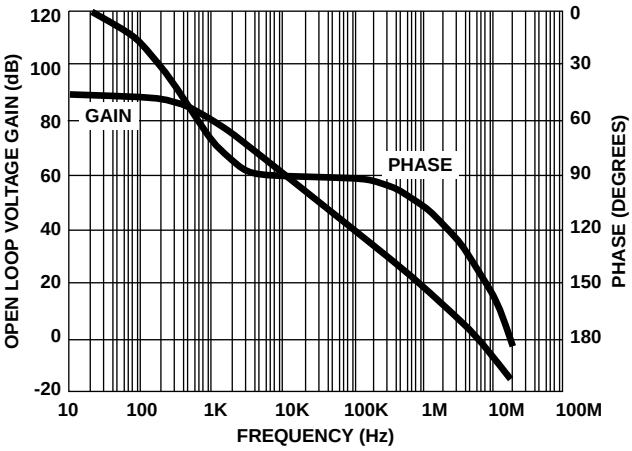



FIGURE 10. OPEN LOOP FREQUENCY AND PHASE RESPONSE

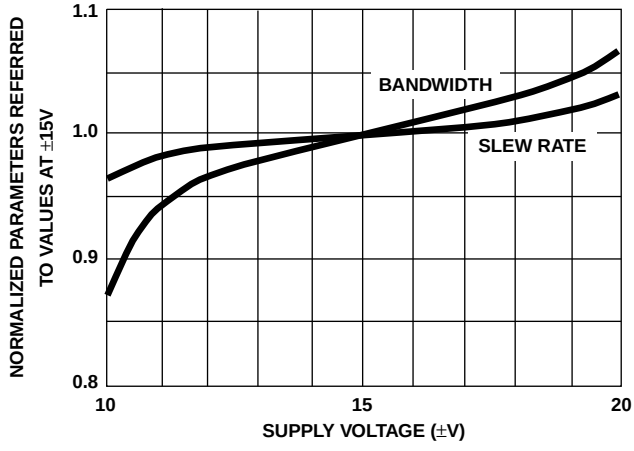
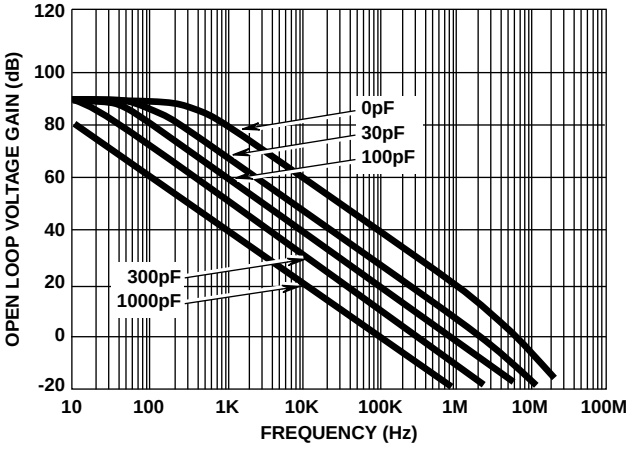



FIGURE 11. NORMALIZED AC PARAMETERS vs SUPPLY VOLTAGE




NOTE: External compensation components are not required for stability, but may be added to reduce bandwidth if desired.

FIGURE 12. OPEN LOOP FREQUENCY RESPONSE FOR VARIOUS VALUES OF CAPACITORS FROM COMPENSATION PIN TO GROUND

## Typical Performance Curves $V_S = \pm15V$, $T_A = 25^oC$, Unless Otherwise Specified **(Continued)**

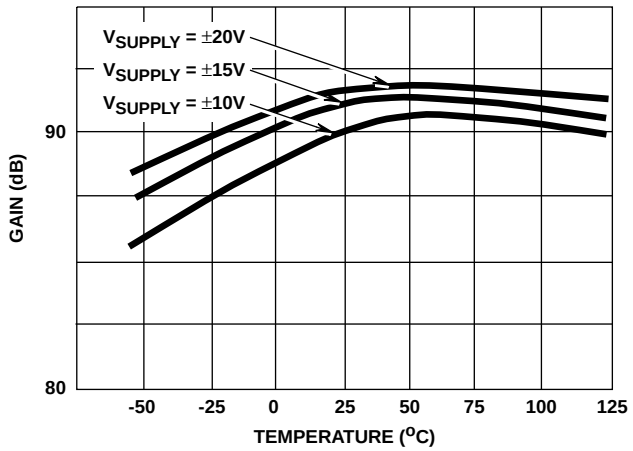



**FIGURE 13. OPEN LOOP VOLTAGE GAIN vs TEMPERATURE**

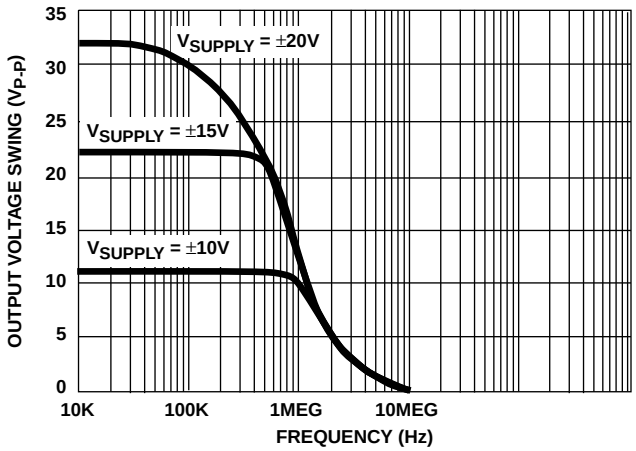



**FIGURE 14. OUTPUT VOLTAGE SWING vs FREQUENCY**

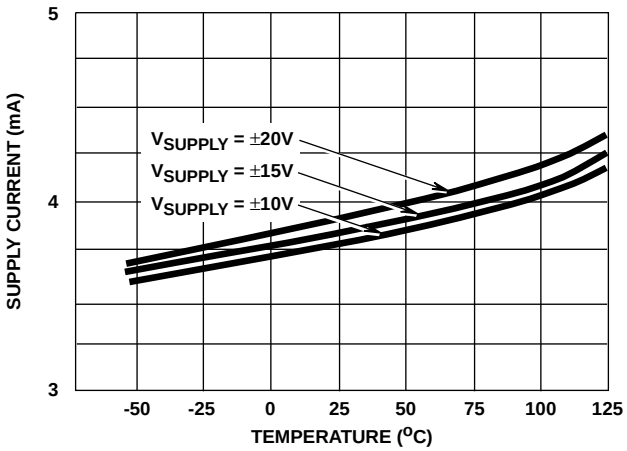



**FIGURE 15. POWER SUPPLY CURRENT vs TEMPERATURE**

## Die Characteristics

**DIE DIMENSIONS:**

57 mils x 65 mils x 19 mils
1450µm x 1650µm x 483µm

**METALLIZATION:**

Type: Al, 1% Cu
Thickness: 16kÅ ± 2kÅ

**PASSIVATION:**

Type: Nitride (Si3N4) over Silox (SiO2, 5% Phos.)
Silox Thickness: 12kÅ ± 2kÅ
Nitride Thickness: 3.5kÅ ± 1.5kÅ

**SUBSTRATE POTENTIAL (Powered Up):**

Unbiased

**TRANSISTOR COUNT:**

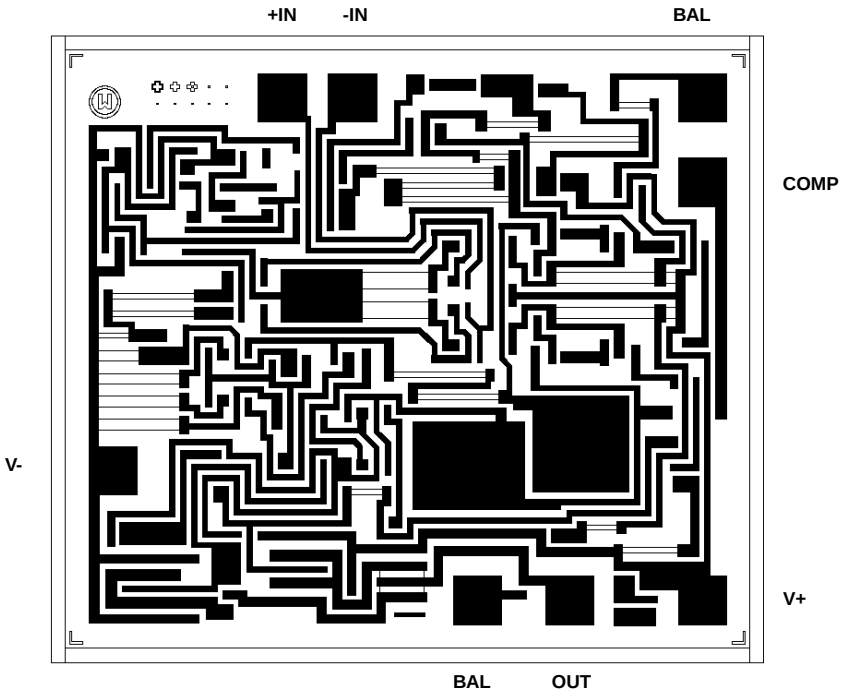
40

**PROCESS:**

Bipolar Dielectric Isolation

## Metallization Mask Layout

**HA-2500, HA-2502**

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