



# HA-2500, HA-2502 HA-2505

## Precision High Slew Rate Operational Amplifiers

March 1993

### Features

- High Slew Rate..... 30V/ $\mu$ s
- Fast Settling..... 330ns
- Wide Power Bandwidth..... 500kHz
- High Gain Bandwidth..... 12MHz
- High Input Impedance..... 50M $\Omega$
- Low Offset Current..... 10nA
- Internally Compensated For Unity Gain Stability

### Applications

- Data Acquisition Systems
- R.F. Amplifiers
- Video Amplifiers
- Signal Generators
- Pulse Amplification

### Ordering Information

PART NUMBER	TEMP. RANGE	PACKAGE
HA2-2500-2	-55°C to +125°C	8 Pin TO-99 Can
HA2-2502-2	-55°C to +125°C	8 Pin TO-99 Can
HA2-2505-5	0°C to +75°C	8 Pin TO-99 Can
HA3-2505-5	0°C to +75°C	8 Lead Plastic DIP
HA4P2505-5	0°C to +75°C	20 Lead Plastic LCC
HA7-2500-2	-55°C to +125°C	8 Lead Ceramic DIP
HA7-2502-2	-55°C to +125°C	8 Lead Ceramic DIP
HA7-2505-5	0°C to +75°C	8 Lead Ceramic DIP

### Description

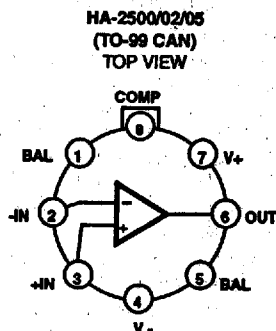
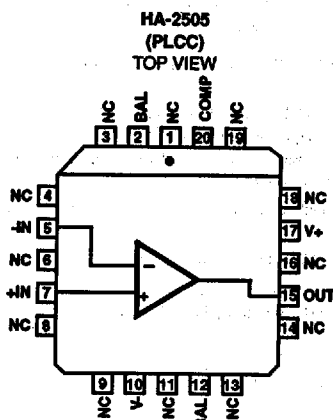
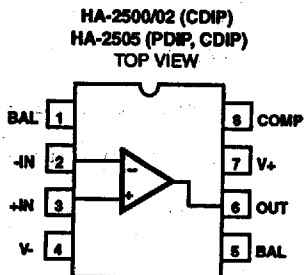
HA-2500, HA-2502, HA-2505 comprises a series of monolithic operational amplifiers whose designs are optimized to deliver excellent slew rate, bandwidth, and settling time specifications. The outstanding dynamic features of this internally compensated device are complemented with low offset voltage and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

These dielectrically isolated amplifiers are ideally suited for applications such as data acquisition, R.F., video, and pulse conditioning circuits. Slew rates of  $\pm 30\text{V}/\mu\text{s}$  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 R.F. 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



CAUTION: These devices are sensitive to electrostatic discharge. Users should follow proper I.C. Handling Procedures.  
Copyright © Harris Corporation 1993

File Number 2890.1

**Specifications HA-2500, HA-2502, HA-2505**

**Absolute Maximum Ratings (Note 6)**

Supply Voltage Between V+ and V- Terminals	40V
Differential Input Voltage	15V
Peak Output Current	50mA
Junction Temperature	+175°C
Junction Temperature (Plastic Package)	+150°C
Lead Temperature (Soldering 10 Sec.)	+300°C

**Operating Conditions**

Operating Temperature Range	$-55^{\circ}\text{C} \leq T_A \leq +125^{\circ}\text{C}$
HA-2500/2502-2	$0^{\circ}\text{C} \leq T_A \leq +75^{\circ}\text{C}$
HA-2505-5	$-65^{\circ}\text{C} \leq T_A \leq +150^{\circ}\text{C}$

**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.

**Electrical Specifications** V+ = +15V, V- = -15V DC

PARAMETER	TEMP	HA-2500-2			HA-2502-2			HA-2505-5			UNITS
		MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
<b>INPUT CHARACTERISTICS</b>											
Offset Voltage	+25°C	-	2	5	-	4	8	-	4	8	mV
	Full	-	-	8	-	-	10	-	-	10	mV
Offset Voltage Average Drift	Full	-	20	-	-	20	-	-	20	-	μV/°C
Bias Current	+25°C	-	100	200	-	125	250	-	125	250	nA
	Full	-	-	400	-	-	500	-	-	500	nA
Offset Current	+25°C	-	10	25	-	20	50	-	20	50	nA
	Full	-	-	50	-	-	100	-	-	100	nA
Input Resistance (Note 10)	+25°C	25	50	-	20	50	-	20	50	-	MΩ
Common Mode Range	Full	±10	-	-	±10	-	-	±10	-	-	V
<b>TRANSFER CHARACTERISTICS</b>											
Large Signal Voltage Gain (Note 1, 4)	+25°C	20	30	-	15	25	-	15	25	-	kV/V
	Full	15	-	-	10	-	-	10	-	-	kV/V
Common Mode Rejection Ratio (Note 2)	Full	80	90	-	74	90	-	74	90	-	dB
Gain Bandwidth Product (Note 3)	+25°C	-	12	-	-	12	-	-	12	-	MHz
<b>OUTPUT CHARACTERISTICS</b>											
Output Voltage Swing (Note 1)	Full	±10	±12	-	±10	±12	-	±10	±12	-	V
Output Current (Note 4)	+25°C	±10	±20	-	±10	±20	-	±10	±20	-	mA
Full Power Bandwidth (Note 4, 11)	+25°C	350	500	-	300	500	-	300	500	-	kHz
<b>TRANSIENT RESPONSE</b>											
Rise Time (Notes 1, 5, 7 and 8)	+25°C	-	25	50	-	25	50	-	25	50	ns
Overshoot (Notes 1, 5, 7 and 8)	+25°C	-	25	40	-	25	50	-	25	50	%
Slew Rate (Notes 1, 5, 8 and 12)	+25°C	±25	±30	-	±20	±30	-	±20	±30	-	V/μs
Settling Time to 0.1% (Note 1, 5, 8 and 12)	+25°C	-	0.33	-	-	0.33	-	-	0.33	-	μs
<b>POWER SUPPLY CHARACTERISTICS</b>											
Supply Current	+25°C	-	4	6	-	4	6	-	4	6	mA
PSRR (Note 9)	Full	80	90	-	74	90	-	74	90	-	dB

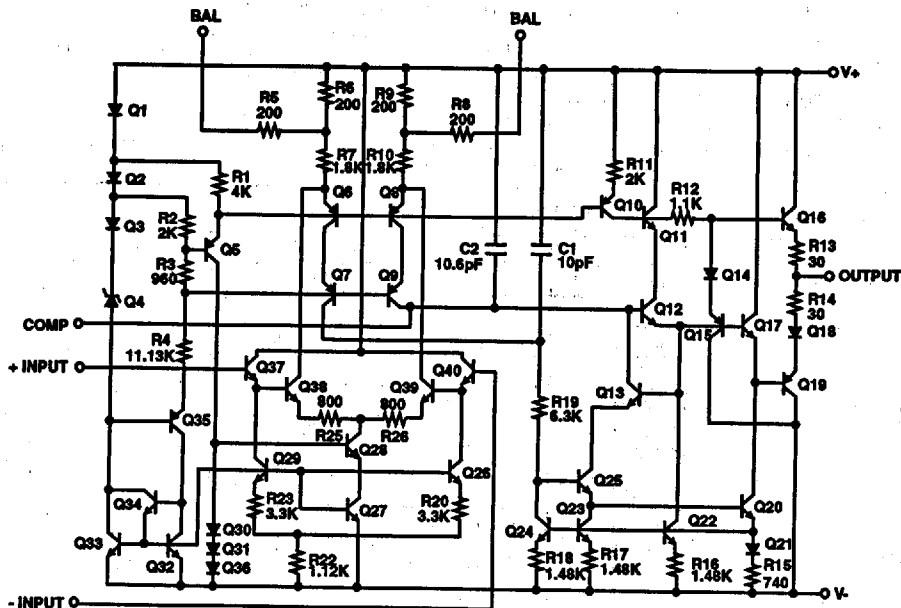
**NOTES:**

1.  $R_L = 2k\Omega$
2.  $V_{CM} = \pm 10V$
3.  $A_V > 10$
4.  $V_O = \pm 10V$
5.  $C_L = 50pF$
6. Absolute Maximum Ratings are limiting values, applied individually, beyond which the serviceability of the circuit may be impaired.

7.  $V_O = \pm 200mV$
8. See Transient Response Test Circuits and Waveforms.
9.  $\Delta V = \pm 5V$
10. This parameter value is based on design calculations.
11. Full Power Bandwidth guaranteed based on slew rate measurement using:  $FPBW = \text{Slew Rate} / 2 \times V_{PEAK}$
12.  $V_{OUT} = \pm 5V$ .

2  
OPERATIONAL AMPLIFIERS

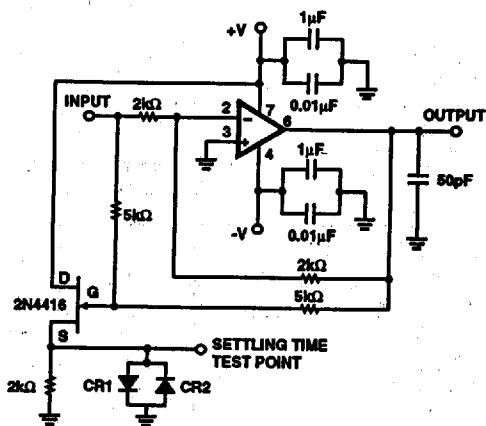
**Schematic**



**Die Characteristics**

Transistor Count .....	40	
Die Dimensions .....	.57 x .65 x .19 mils	
Substrate Potential .....	Unbiased	
Process .....	Bipolar-DI	
Thermal Constants (°C/W)	$\theta_{JA}$	$\theta_{JC}$
Metal Can .....	117	36
Plastic Mini-DIP .....	96	34
Ceramic Mini-DIP .....	115	36
Plastic LCC .....	74	33

**Settling Time Circuit**



- $A_v = -1$
- Feedback and Summing Resistor Ratios should be 0.1% matched.
- Clipping Diodes CR1 and CR2 are optional. HP5082-2810 recommended.

HA-2500, HA-2502, HA-2505

Test Circuits

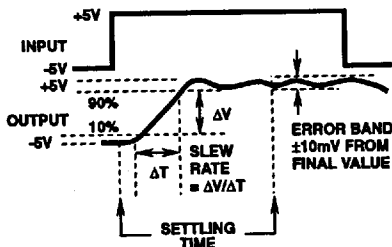


FIGURE 1. SLEW RATE AND SETTLING TIME

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

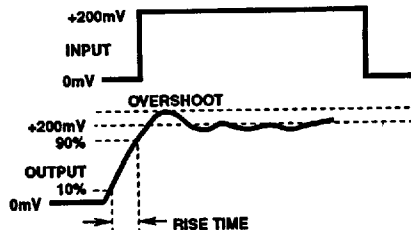


FIGURE 2. TRANSIENT RESPONSE

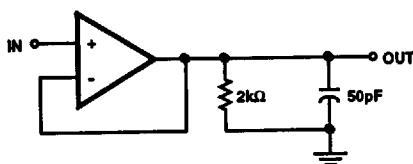


FIGURE 3. SLEW RATE AND TRANSIENT RESPONSE

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

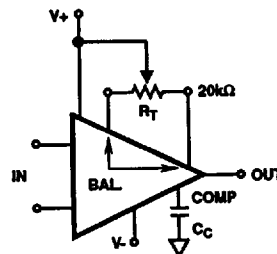


FIGURE 4. SUGGESTED  $V_{OS}$  ADJUSTMENT AND COMPENSATION HOOK UP

Tested offset adjustment range is  $IV_{OS} + 1mV$  minimum referred to output. Typical ranges are  $\pm 6mV$  with  $R_T = 20k\Omega$

Typical Performance Curves  $V_+ = +15VDC, V_- = -15VDC, T_A = +25^\circ C$ , Unless Otherwise Specified

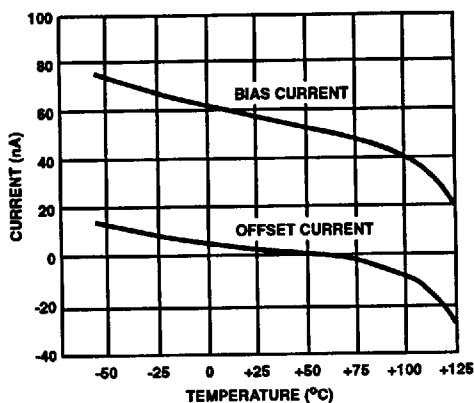


FIGURE 5. INPUT BIAS AND OFFSET CURRENT vs. TEMPERATURE

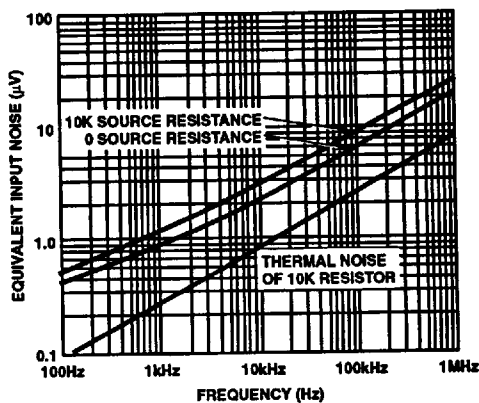


FIGURE 6. EQUIVALENT INPUT NOISE vs. BANDWIDTH (With 10Hz High Pass Filter)

HA-2500, HA-2502, HA-2505

**Typical Performance Curves**  $V_+ = +15VDC$ ,  $V_- = -15VDC$ ,  $T_A = +25^\circ C$ , Unless Otherwise Specified (Continued)

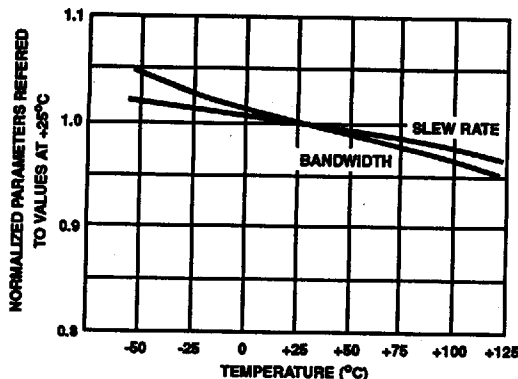


FIGURE 7. NORMALIZED AC PARAMETERS vs TEMPERATURE

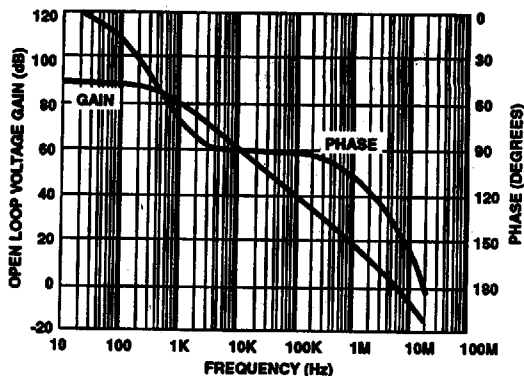


FIGURE 8. OPEN LOOP FREQUENCY AND PHASE RESPONSE

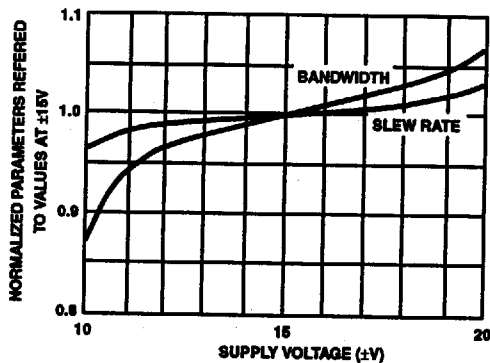


FIGURE 9. NORMALIZED AC PARAMETERS vs SUPPLY VOLTAGE AT +25°C

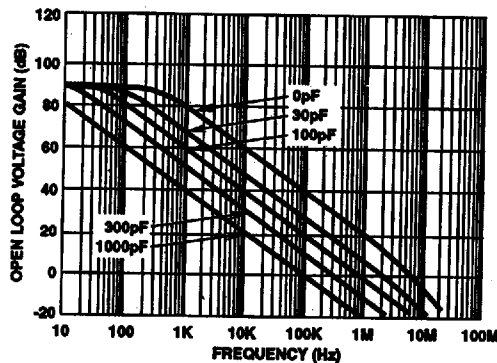


FIGURE 10. OPEN LOOP FREQUENCY RESPONSE FOR VARIOUS VALUES OF CAPACITORS FROM COMPENSATION PIN TO GROUND

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

HA-2500, HA-2502, HA-2505

**Typical Performance Curves**  $V_+ = +15VDC$ ,  $V_- = -15VDC$ ,  $T_A = +25^\circ C$ , Unless Otherwise Specified (Continued)

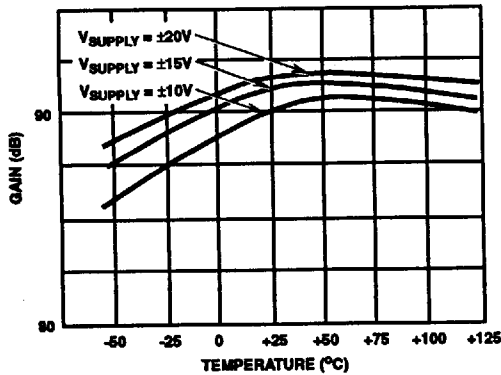


FIGURE 11. OPEN LOOP VOLTAGE GAIN vs TEMPERATURE

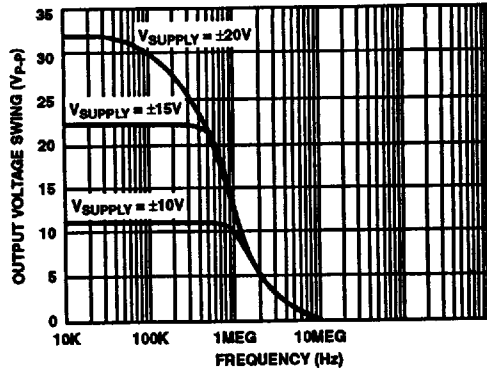


FIGURE 12. OUTPUT VOLTAGE SWING vs FREQUENCY AT  $+25^\circ C$

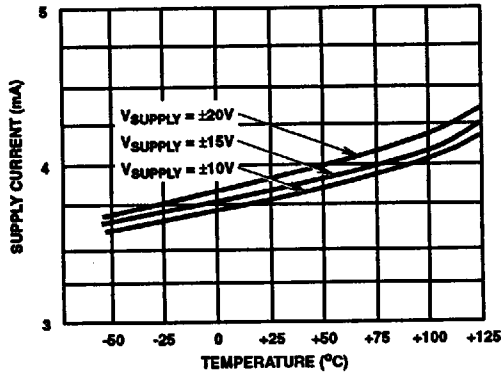


FIGURE 13. POWER SUPPLY CURRENT vs TEMPERATURE

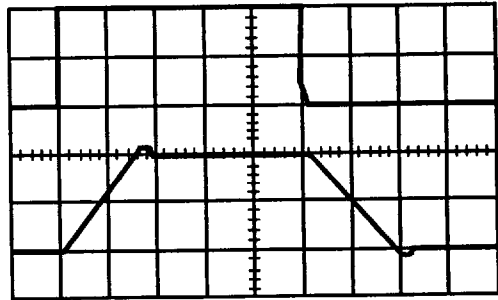


FIGURE 14. VOLTAGE FOLLOWER PULSE RESPONSE

$R_L = 2k\Omega$ ,  $C_L = 50pF$       Vertical = 5V/Div.  
 Upper Trace: Input                  Horizontal = 200ns/Div.  
 Lower Trace: Output                 $T_A = +25^\circ C$ ,  $V_S = \pm 15V$