

## Very Wideband, Uncompensated Operational Amplifiers

### Features

- Gain Bandwidth Product ( $A_v \geq 5$ ) ..... 100MHz
- High Input Impedance ..... 500M $\Omega$
- Low Input Bias Current ..... 1nA
- Low Input Offset Current ..... 1nA
- Low Input Offset Voltage ..... 0.5mV
- High Gain ..... 150kV/V
- High Slew Rate ..... 35V/ $\mu$ s
- Output Short Circuit Protection

### Description

HA-2620/2622/2625 are bipolar operational amplifiers that feature very high input impedance (500M $\Omega$ , HA-2620) coupled with wideband AC performance. The high resistance of the input stage is complemented by low offset voltage (0.5mV, HA-2620) and low bias and offset current (1nA, HA-2620) to facilitate accurate signal processing. Input offset can be reduced further by means of an external nulling potentiometer. 100MHz gain-bandwidth product (HA-2620/2622/2625 are stable for closed loop gains greater than 5), 35V/ $\mu$ s slew rate and 150kV/V open-loop gain enables HA-2620/2622/2625 to perform high-gain amplification of very 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 (e.g. video) applications. The frequency response of the amplifier can be tailored to exact

### Applications

- Video and R.F. Amplifier
- Pulse Amplifier
- Audio Amplifiers and Filters
- High-Q Active Filters
- High-Speed Comparators
- Low Distortion Oscillators

design requirements by means of an external bandwidth control capacitor.

In addition to its application in pulse and video amplifier designs, HA-2620/2622/2625 is particularly suited to other high performance designs such as high-gain low distortion audio amplifiers, high-Q and wideband active filters and high-speed comparators. For more information, please refer to Application Notes 509, 519 and 546.

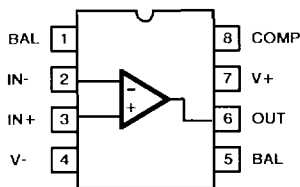
The HA-2620 and HA-2622 have guaranteed operation from -55 $^{\circ}$ C to +125 $^{\circ}$ C and are available in Metal Can and Ceramic Mini-DIP packages. Both are offered as /883 Military Grade with the HA-2622 also available in LCC packages. MIL-STD-883 data sheets are available upon request. The HA-2625 has guaranteed operation from 0 $^{\circ}$ C to +75 $^{\circ}$ C and is available in Plastic and Ceramic Mini-DIP and Metal Can packages.

### Pinouts

HA7-2620/22/25 (CERAMIC MINI-DIP)

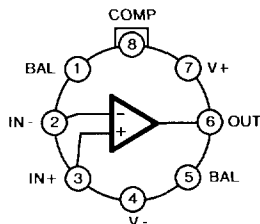
HA3-2625 (PLASTIC MINI-DIP)

TOP VIEW

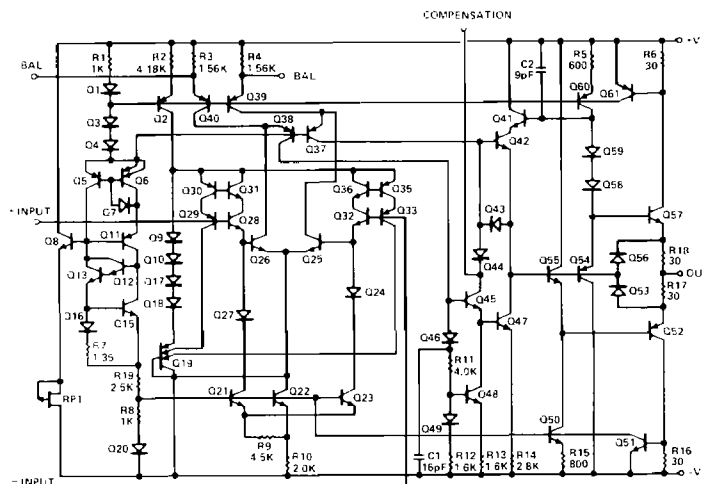


HA2-2620/22/25 (TO-99 METAL CAN)

TOP VIEW



### Schematic



# Specifications HA-2620/22/25

## Absolute Maximum Ratings (Note 13)

Voltage Between V+ and V- Terminals	45.0V
Differential Input Voltage	±12.0V
Peak Output Current	Full Short Circuit Protection
Internal Power Dissipation	300mW
Maximum Junction Temperature	+175°C

## Operating Temperature Ranges

HA-2600/HA-2602	-55°C ≤ T <sub>A</sub> ≤ +125°C
HA-2605	0°C ≤ T <sub>A</sub> ≤ +75°C
Storage Temperature Range	-65°C ≤ T <sub>A</sub> ≤ +150°C
Lead Solder Temperature (10 Seconds)	275°C

## Electrical Specifications V<sub>S</sub> = ±15V D.C., Unless Otherwise Specified.

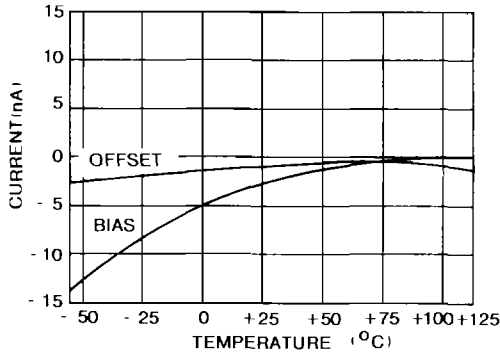
PARAMETER	TEMP	HA-2620 -55°C to +125°C			HA-2622 -55°C to +125°C			HA-2625 0°C to +75°C			UNITS
		MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
INPUT CHARACTERISTICS											
Offset Voltage (Note 1)	+25°C	-	0.5	4	-	3	5	-	3	5	mV
	Full	-	2	6	-	-	7	-	-	7	mV
Average Offset Voltage Drift	Full	-	5	-	-	5	-	-	5	-	μV/°C
Bias Current	+25°C	-	1	15	-	5	25	-	5	25	nA
	Full	-	10	35	-	-	60	-	-	40	nA
Offset Current	+25°C	-	1	15	-	5	25	-	5	25	nA
	Full	-	5	35	-	-	60	-	-	40	nA
Differential Input Resistance (Note 11)	+25°C	65	500	-	40	300	-	40	300	-	MΩ
Input Noise Voltage Density f <sub>0</sub> = 1kHz	+25°C	-	11	-	-	11	-	-	11	-	nV/√Hz
Input Noise Current Density f <sub>0</sub> = 1kHz	+25°C	-	0.16	-	-	0.16	-	-	0.16	-	pA/√Hz
Common Mode Range	Full	±11	±12	-	±11	±12	-	±11	±12	-	V
TRANSFER CHARACTERISTICS											
Large Signal Voltage Gain (Notes 2 & 3)	+25°C	100K	150K	-	80K	150K	-	80K	150K	-	V/V
	Full	70K	-	-	60K	-	-	70K	-	-	V/V
Common Mode Rejection Ratio (Note 4)	Full	80	100	-	74	100	-	74	100	-	dB
Minimum Stable Gain	+25°C	5	-	-	5	-	-	5	-	-	V/V
Gain Bandwidth Product (Notes 2, 5 & 6)	+25°C	-	100	-	-	100	-	-	100	-	MHz
OUTPUT CHARACTERISTICS											
Output Voltage Swing (Note 2)	Full	±10	±12	-	±10	±12	-	±10	±12	-	V
Output Current (Note 3)	+25°C	±15	±22	-	±10	±18	-	±10	±18	-	mA
Full Power Bandwidth (Notes 2, 3, 7 & 12)	+25°C	400	600	-	320	600	-	320	600	-	kHz
TRANSIENT RESPONSE (Note 8)											
Rise Time (Notes 2, 7 & 8)	+25°C	-	17	45	-	17	45	-	17	45	ns
Slew Rate (Notes 2, 7, 8 & 10)	+25°C	±25	±35	-	±20	±35	-	±20	±35	-	V/μs
POWER SUPPLY CHARACTERISTICS											
Supply Current	+25°C	-	3	3.7	-	3	4	-	3	4	mA
Power Supply Rejection Ratio (Note 9)	Full	80	90	-	74	90	-	74	90	-	dB

### NOTES:

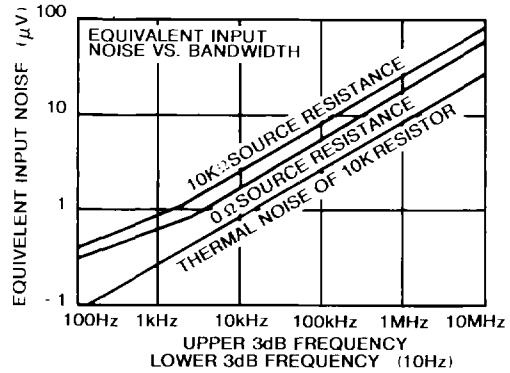
- Offset may be externally adjusted to zero.
- R<sub>L</sub> = 2kΩ
- V<sub>OUT</sub> = ±10.0V
- V<sub>CM</sub> = ±10V
- V<sub>OUT</sub> < 90mV
- 40dB Gain
- See Transient Response Test Circuits & Waveforms.
- A<sub>V</sub> = 5 (The HA-2620 family is not stable at unity gain without external compensation.)
- ΔV<sub>S</sub> = ±5V
- V<sub>OUT</sub> = ±5V
- This parameter value guaranteed by design calculations.
- Full Power Bandwidth guaranteed by slew rate measurement:  
FPBW = S.R./2πV<sub>PEAK</sub>
- Absolute Maximum Ratings are limiting values applied individually beyond which the serviceability of the circuit may be impaired. Functional operation under any of these conditions is not necessarily implied.

**Typical Performance Curves**  $V_S = \pm 15V$  D.C.,  $T_A = +25^\circ C$ , Unless Otherwise Specified.

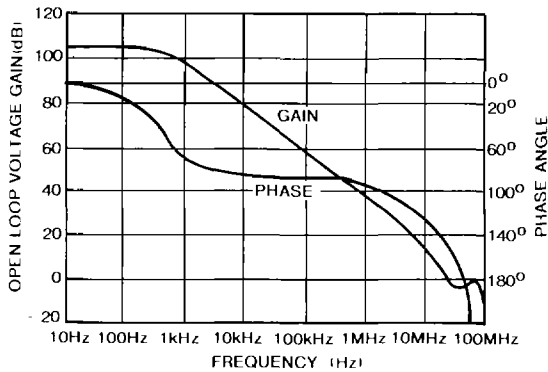
**INPUT BIAS CURRENT AND OFFSET CURRENT AS A FUNCTION OF TEMPERATURE**



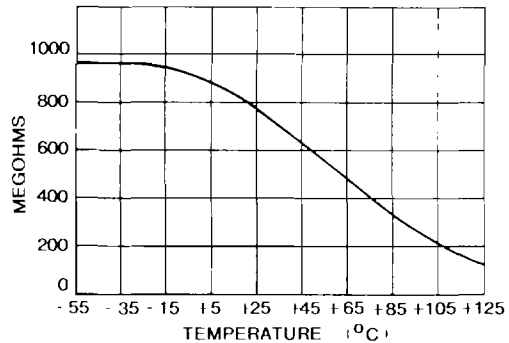
**BROADBAND NOISE CHARACTERISTICS**



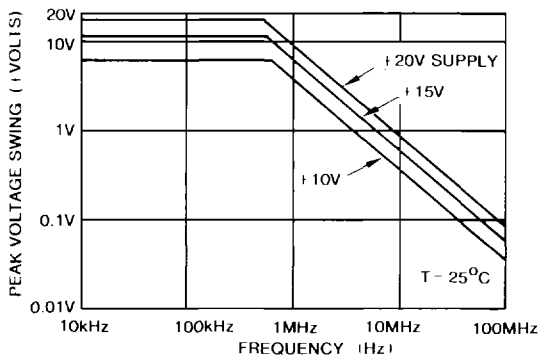
**OPEN LOOP FREQUENCY AND PHASE RESPONSE**



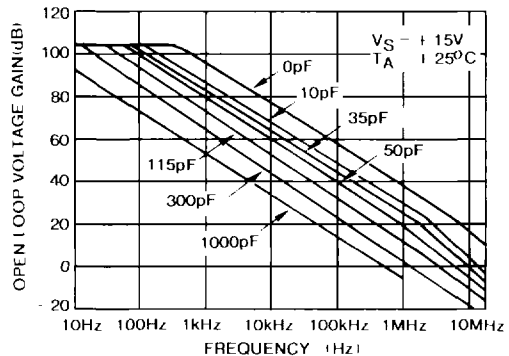
**INPUT IMPEDANCE vs. TEMPERATURE, 100Hz**



**OUTPUT VOLTAGE SWING vs. FREQUENCY**



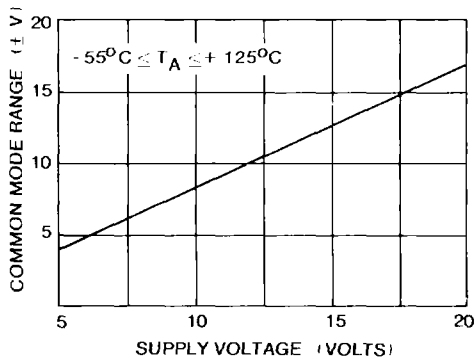
**OPEN - LOOP FREQUENCY RESPONSE FOR VARIOUS VALUES OF CAPACITORS FROM COMPENSATION PIN TO GROUND**



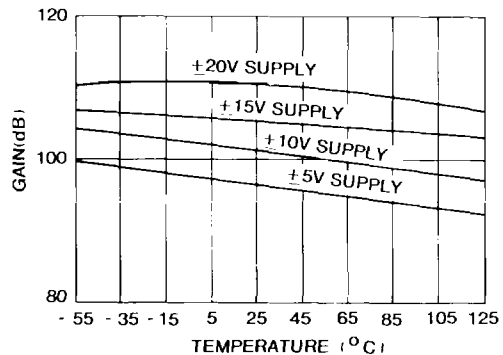
NOTE: External Compensation is required for closed loop gain < 5. If external compensation is used, also connect 100pF capacitor from output to ground.

**Typical Performance Curves (Continued)**

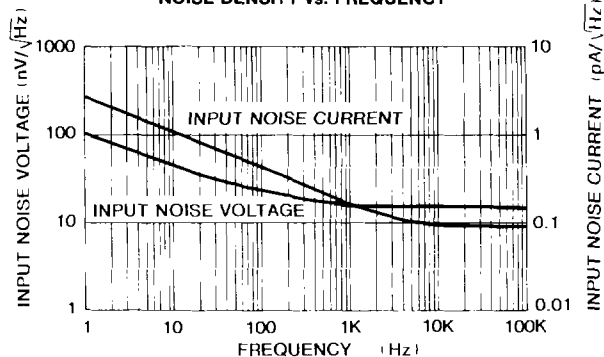
**COMMON MODE VOLTAGE RANGE  
AS A FUNCTION OF SUPPLY VOLTAGE**



**OPEN - LOOP VOLTAGE GAIN vs. TEMPERATURE**

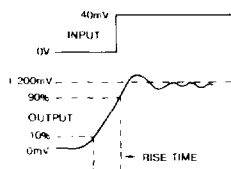


**NOISE DENSITY vs. FREQUENCY**

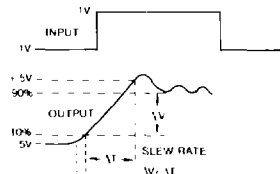


**Test Circuits**

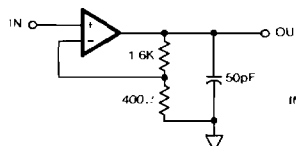
**TRANSIENT RESPONSE**



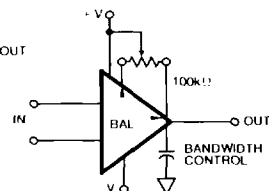
**SLEW RATE**



**SLEW RATE AND  
TRANSIENT RESPONSE**



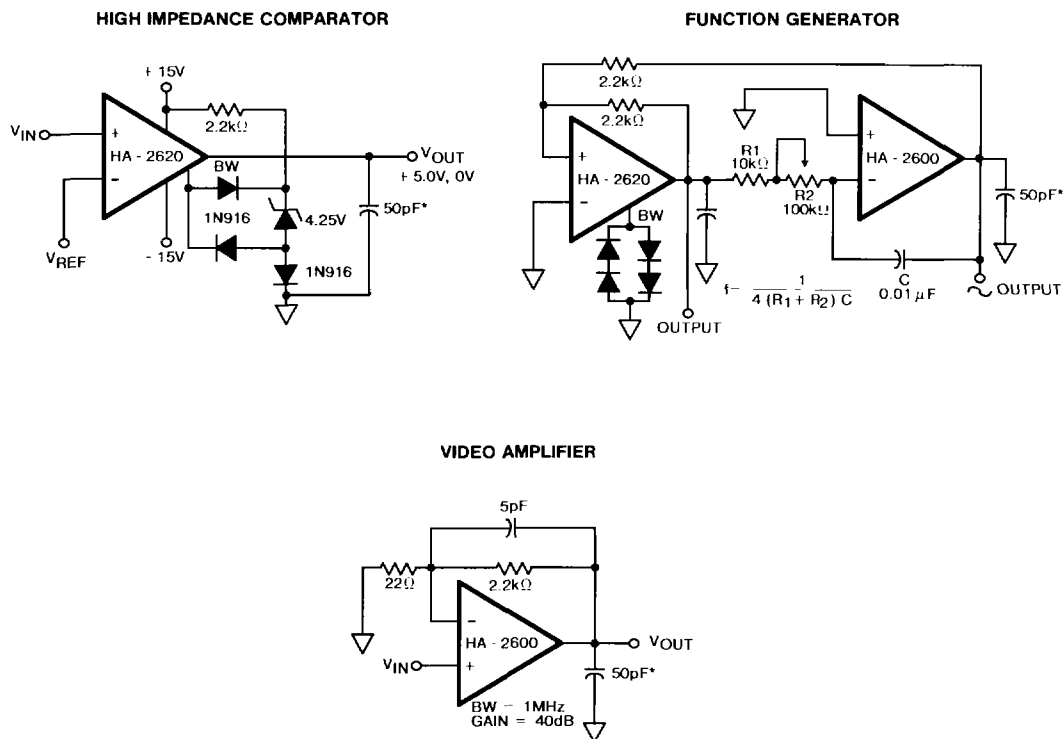
**SUGGESTED  $V_{OS}$  ADJUST-  
MENT AND COMPENSATION  
HOOK-UP**



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

Tested Offset Adjustment is  $|V_{OS} + 1\text{mV}|$  minimum referred to output. Typical range is  $\pm 10\text{mV}$  with  $R_T = 100\text{k}\Omega$ .

## Typical Applications



\* A small load capacitance of at least 30pF (including stray capacitance) is recommended to prevent possible high frequency oscillations.

## Die Characteristics

Transistor Count ..... 140  
 Die Dimensions ..... 73 x 52 x 19 mils  
 Substrate Potential ..... Unbiased

Thermal Constants (°C/W)	$\theta_{ja}$	$\theta_{jc}$
HA2-Metal Can (-2, -5, -7)	202	55
HA2-Metal Can (-8, /883)	161	48
HA3-Plastic DIP (-5)	83	33
HA4-Ceramic LCC (/883)	96	35
HA7-Ceramic DIP (-2, -5, -7)	204	112
HA7-Ceramic DIP (-8, /883)	81	32