# HA-2620, HA-2625

100MHz, High Input Impedance, Very Wideband, Uncompensated Operational Amplifiers

FN2903
Rev 8.00
January 16, 2006

HA-2620/2625 are bipolar operational amplifiers that feature very high input impedance (500MΩ, 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. The 100MHz gain bandwidth product (HA-2620/2625 are stable for closed loop gains greater than 5), 35V/μs slew rate and 150kV/V open loop gain enables HA-2620/2625 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 design requirements by means of an external bandwidth control capacitor connected from the Comp pin to GND.

In addition to its application in pulse and video amplifier designs, HA-2620/2625 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 AN509, AN519 and AN546.

## Ordering Information

| PART NUMBER | PART MARKING | TEMP. RANGE ($^{o}$C) | PACKAGE | PKG. DWG. # |
|---|---|---|---|---|
| HA2-2620-2 | HA2-2620-2 | -55 to 125 | 8 Pin Metal Can | T8.C |
| HA3-2625-5 | HA3-2625-5 | 0 to 75 | 8 Ld PDIP | E8.3 |
| HA9P2625-9 | 26259 | -40 to 85 | 8 Ld SOIC | M8.15 |

## Features

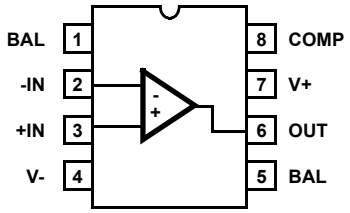
- Gain Bandwidth Product ($A_V \geq 5$) . . . . . 100MHz
- High Input Impedance . . . . . 300MΩ
- Low Input Bias Current . . . . . 5nA
- Low Input Offset Current . . . . . 5nA
- Low Input Offset Voltage . . . . . 3mV
- High Gain . . . . . 150kV/V
- Slew Rate . . . . . 35V/μs
- Output Short Circuit Protection
- Compensation Pin for Unity Gain Capability

## Applications

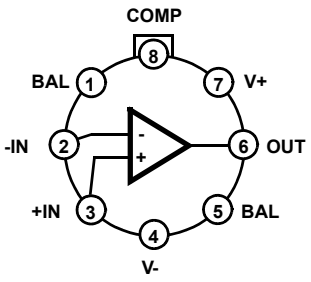
- Video and RF Amplifier
- Pulse Amplifier
- Audio Amplifiers and Filters
- High-Q Active Filters
- High Speed Comparators
- Low Distortion Oscillator

## Pinouts

**HA-2625 (PDIP, SOIC)**
TOP VIEW




**HA-2620 (METAL CAN)**
TOP VIEW



## Absolute Maximum Ratings

Supply Voltage (Between V+ and V- Terminals) . . . . . 45V
Differential Input Voltage . . . . . 12V
Peak Output Current . . . . . Full Short Circuit Protection

## Operating Conditions

Temperature Range
HA-2620-2 . . . . . -55°C to 125°C
HA-2625-5 . . . . . 0°C to 75°C
HA-2625-9 . . . . . -40°C to 85°C

## Thermal Information

| Thermal Resistance (Typical, Note 1) | $\theta_{JA}$ (°C/W) | $\theta_{JC}$ (°C/W) |
|---|---|---|
| PDIP Package | 117 | N/A |
| SOIC Package | 165 | N/A |
| Metal Can Package | 165 | 80 |

Maximum Junction Temperature (Hermetic Package) . . . . . 175°C
Maximum Junction Temperature (Plastic Package) . . . . . 150°C
Maximum Storage Temperature Range . . . . . -65°C to 150°C
Maximum Lead Temperature (Soldering 10s) . . . . . 300°C
(SOIC - Lead Tips Only)

*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

$V_{SUPPLY}$ = ±15V, Unless Otherwise Specified

| PARAMETER | TEMP. (°C) | HA-2620 | | | HA-2625 | | | UNITS |
|---|---|---|---|---|---|---|---|---|
| | | MIN | TYP | MAX | MIN | TYP | MAX | |
| **INPUT CHARACTERISTICS** | | | | | | | | |
| Offset Voltage (Note 3) | 25 | - | 0.5 | 4 | - | 3 | 5 | mV |
| | Full | - | 2 | 6 | - | - | 7 | mV |
| Average Offset Voltage Drift | Full | - | 5 | - | - | 5 | - | µV/°C |
| Bias Current | 25 | - | 1 | 15 | - | 5 | 25 | nA |
| | Full | - | 10 | 35 | - | - | 40 | nA |
| Offset Current | 25 | | 1 | 15 | - | 5 | 25 | nA |
| | Full | - | 5 | 35 | - | - | 40 | nA |
| Differential Input Resistance (Note 2) | 25 | 65 | 500 | - | 40 | 300 | - | MΩ |
| Input Noise Voltage Density (f = 1kHz) | 25 | - | 11 | - | - | 11 | - | nV/√Hz |
| Input Noise Current Density (f = 1kHz) | 25 | - | 0.16 | - | - | 0.16 | - | pA/√Hz |
| Common Mode Range | Full | ±11 | ±12 | - | ±11 | ±12 | - | V |
| **TRANSFER CHARACTERISTICS** | | | | | | | | |
| Large Signal Voltage Gain (Notes 4, 5) | 25 | 100 | 150 | - | 80 | 150 | - | kV/V |
| | Full | 70 | - | - | 70 | - | - | kV/V |
| Common Mode Rejection Ratio (Note 6) | Full | 80 | 100 | - | 74 | 100 | - | dB |
| Minimum Stable Gain | 25 | 5 | - | - | 5 | - | - | V/V |
| Gain Bandwidth Product (Notes 4, 7, 8) | 25 | - | 100 | - | - | 100 | - | MHz |
| **OUTPUT CHARACTERISTICS** | | | | | | | | |
| Output Voltage Swing (Note 4) | Full | ±10 | ±12 | - | ±10 | ±12 | - | V |
| Output Current (Note 5) | 25 | ±15 | ±22 | - | ±10 | ±18 | - | mA |
| Full Power Bandwidth (Notes 4, 5, 9, 13) | 25 | 400 | 600 | - | 320 | 600 | - | kHz |

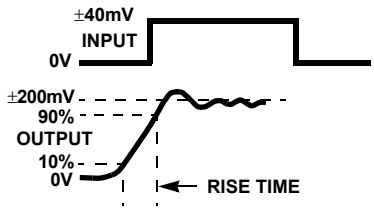
**Electrical Specifications** $V_{SUPPLY}$ = ±15V, Unless Otherwise Specified **(Continued)**

| PARAMETER | TEMP. (°C) | HA-2620 | | | HA-2625 | | | UNITS |
|---|---|---|---|---|---|---|---|---|
| | | MIN | TYP | MAX | MIN | TYP | MAX | |
| **TRANSIENT RESPONSE** (Note 8) | | | | | | | | |
| Rise Time (Notes 4, 9, 10) | 25 | - | 17 | 45 | - | 17 | 45 | ns |
| Slew Rate (Notes 4, 9, 10, 12) | 25 | ±25 | ±35 | - | ±20 | ±35 | - | V/µs |
| **POWER SUPPLY CHARACTERISTICS** | | | | | | | | |
| Supply Current | 25 | - | 3 | 3.7 | - | 3 | 4 | mA |
| Power Supply Rejection Ratio (Note 11) | Full | 80 | 90 | - | 74 | 90 | - | dB |

NOTES:

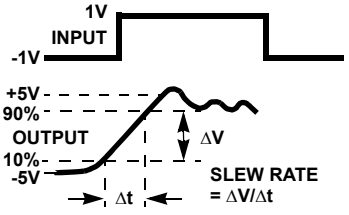
2. This parameter value guaranteed by design calculations.
3. Offset may be externally adjusted to zero.
4. $R_L$ = 2kΩ.
5. $V_{OUT}$ = ±10V.
6. $V_{CM}$ = ±10V.
7. $V_{OUT}$ < 90mV.
8. 40dB Gain.
9. See Transient Response Test Circuits and Waveforms.
10. $A_V$ = 5 (The HA-2620 family is not stable at unity gain without external compensation).
11. $\Delta V_S$ = ±5V.
12. $V_{OUT}$ = ±5V.
13. Full Power Bandwidth guaranteed by slew rate measurement: $FPBW = \frac{\text{Slew Rate}}{2\pi V_{PEAK}}$.

## *Test Circuits and Waveforms*

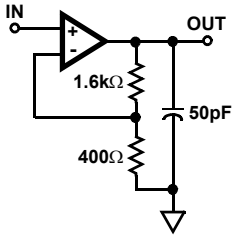



NOTE: Measured on both positive and negative transitions from 0V to +200mV and 0V to -200mV at output.

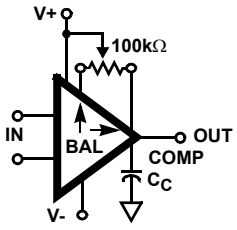
**TRANSIENT RESPONSE**




**SLEW RATE**



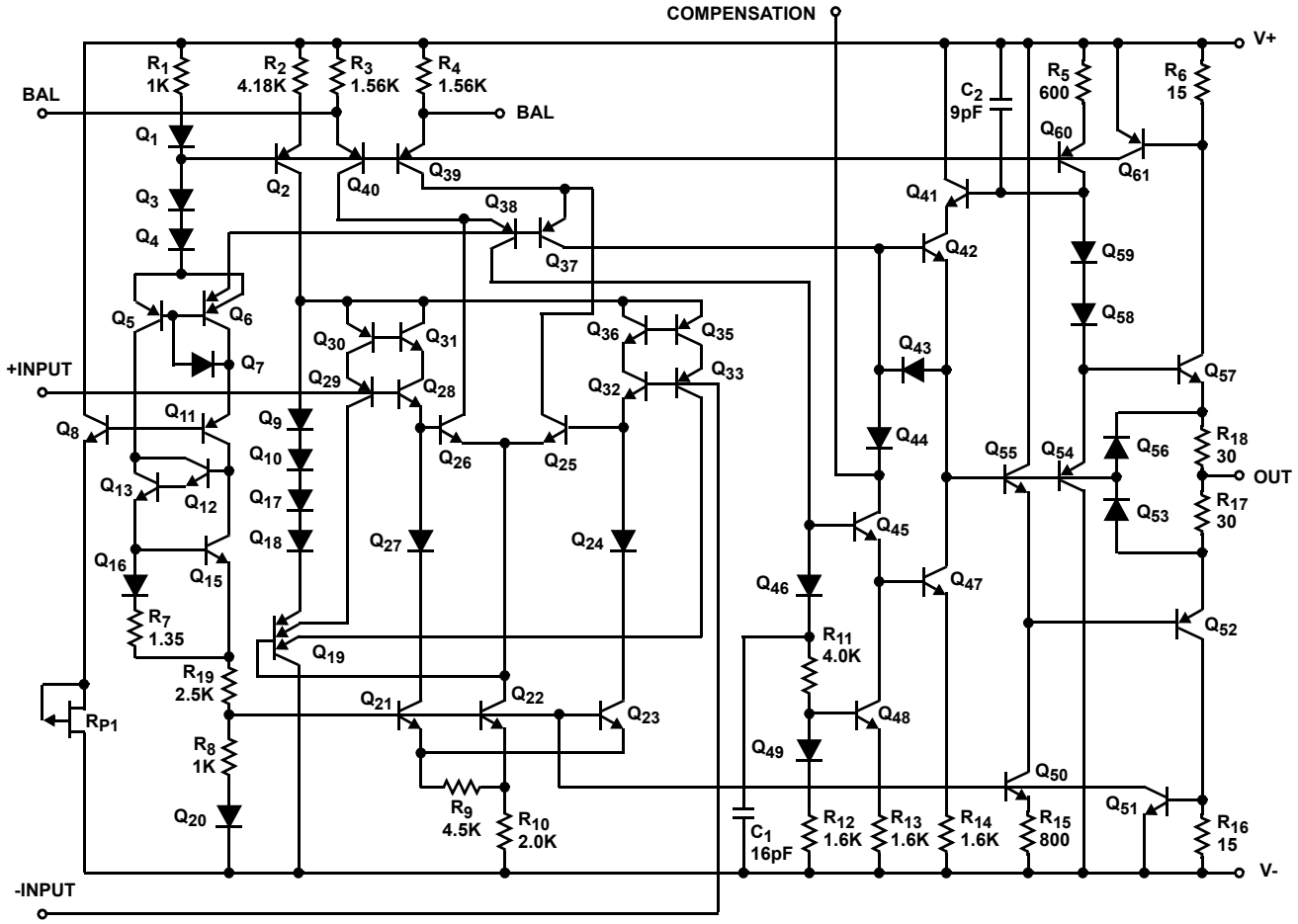

**SLEW RATE AND TRANSIENT RESPONSE**




NOTE: Tested Offset Adjustment is $|V_{OS}$ + 1mV| minimum referred to output. Typical range is ±10mV with $R_T$ = 100kΩ.

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

## Schematic Diagram




## Typical Applications

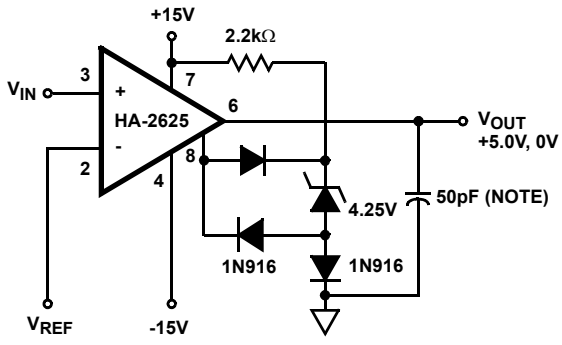



FIGURE 1. HIGH INPUT IMPEDANCE COMPARATOR

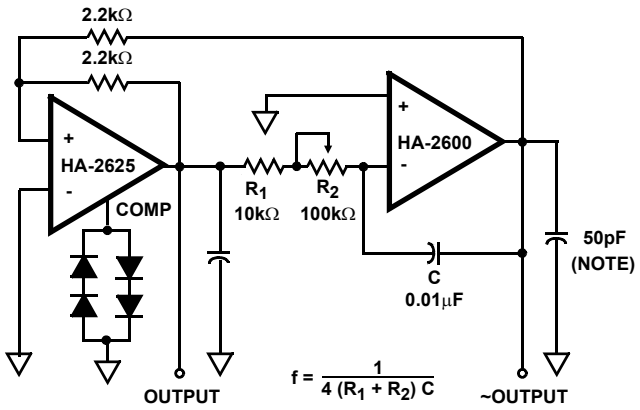
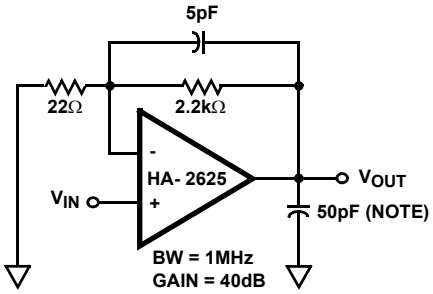



FIGURE 2. FUNCTION GENERATOR

## *Typical Applications* (Continued)




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

**FIGURE 3. VIDEO AMPLIFIER**

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

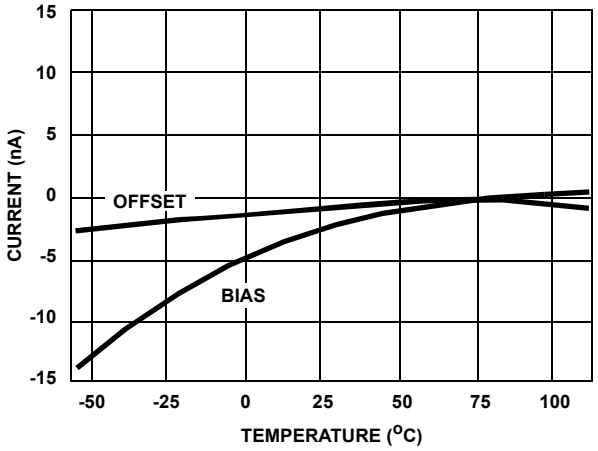



**FIGURE 4. INPUT BIAS CURRENT AND OFFSET CURRENT vs TEMPERATURE**

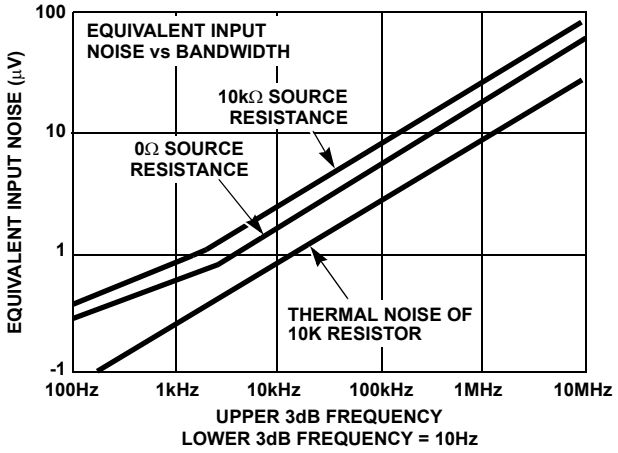



**FIGURE 5. BROADBAND NOISE CHARACTERISTICS**

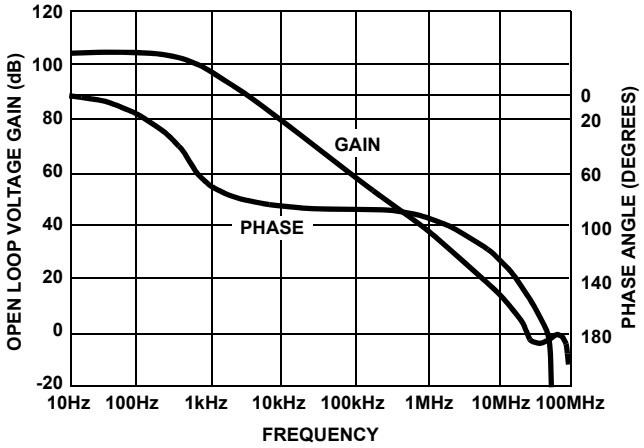



**FIGURE 6. OPEN LOOP FREQUENCY RESPONSE**

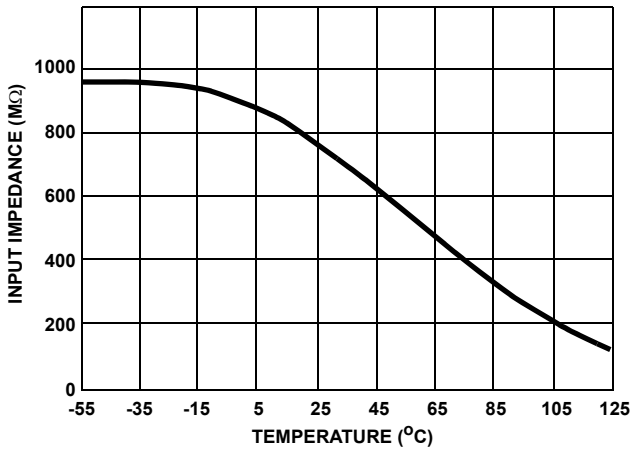



**FIGURE 7. INPUT IMPEDANCE vs TEMPERATURE, 100Hz**

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

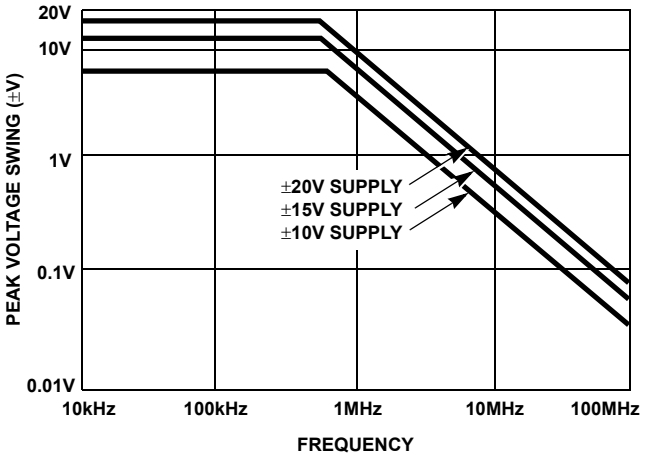
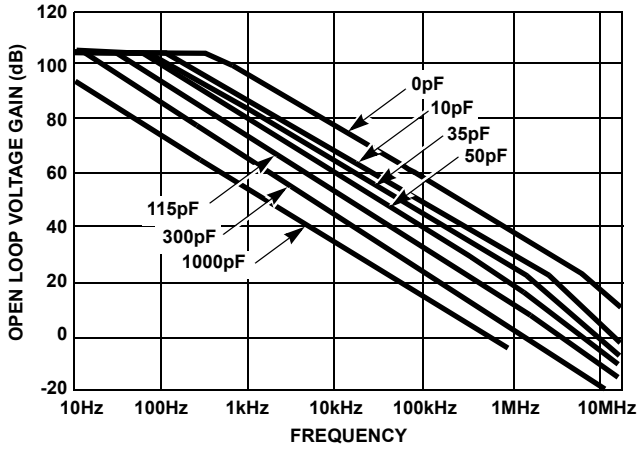



FIGURE 8. OUTPUT VOLTAGE SWING vs FREQUENCY




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

FIGURE 9. OPEN LOOP FREQUENCY RESPONSE FOR VARIOUS VALUES OF CAPACITORS FROM COMP. PIN TO GND

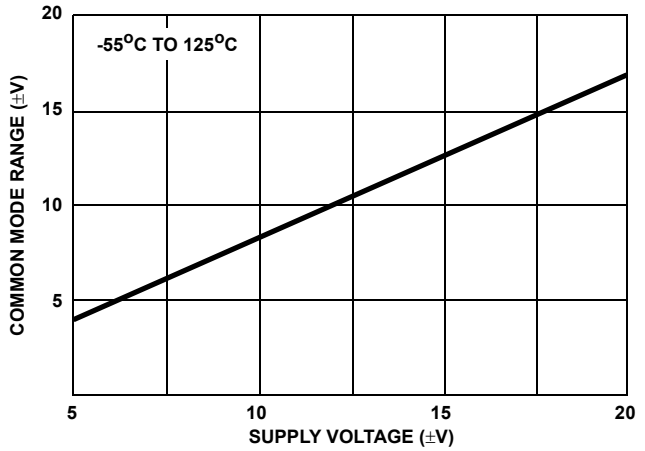



FIGURE 10. COMMON MODE VOLTAGE RANGE vs SUPPLY VOLTAGE

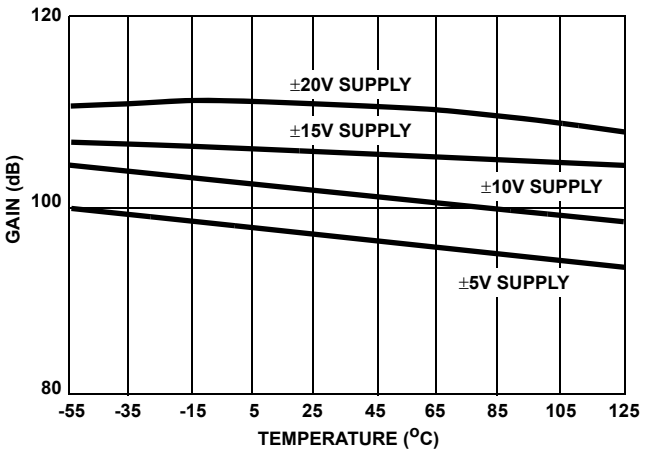



FIGURE 11. OPEN LOOP VOLTAGE GAIN vs TEMPERATURE

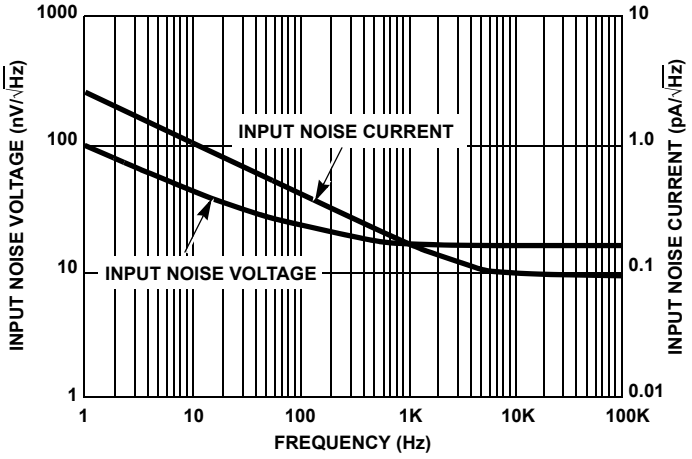



FIGURE 12. NOISE DENSITY vs FREQUENCY

## Die Characteristics

**SUBSTRATE POTENTIAL (POWERED UP):**

Unbiased

**TRANSISTOR COUNT:**

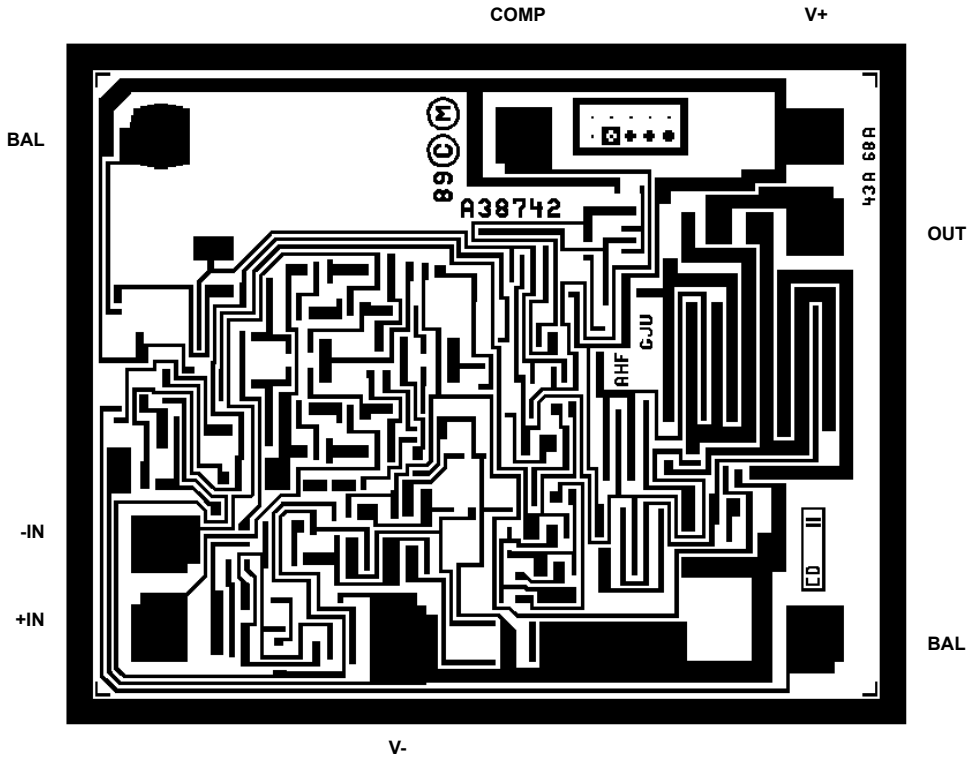
140

**PROCESS:**

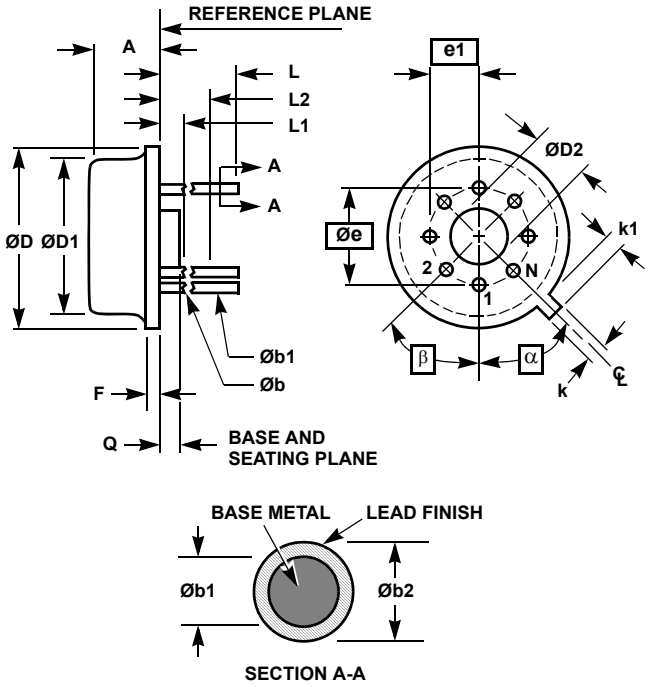
Bipolar Dielectric Isolation

## Metallization Mask Layout

**HA-2620, HA-2625**



## *Metal Can Packages (Can)*




NOTES:

1. (All leads) Øb applies between L1 and L2. Øb1 applies between L2 and 0.500 from the reference plane. Diameter is uncontrolled in L1 and beyond 0.500 from the reference plane.
2. Measured from maximum diameter of the product.
3. $\alpha$ is the basic spacing from the centerline of the tab to terminal 1 and $\beta$ is the basic spacing of each lead or lead position (N -1 places) from $\alpha$, looking at the bottom of the package.
4. N is the maximum number of terminal positions.
5. Dimensioning and tolerancing per ANSI Y14.5M - 1982.
6. Controlling dimension: INCH.

**T8.C MIL-STD-1835 MACY1-X8 (A1)**
**8 LEAD METAL CAN PACKAGE**

| SYMBOL | INCHES | | MILLIMETERS | | NOTES |
|---|---|---|---|---|---|
| | MIN | MAX | MIN | MAX | |
| A | 0.165 | 0.185 | 4.19 | 4.70 | - |
| Øb | 0.016 | 0.019 | 0.41 | 0.48 | 1 |
| Øb1 | 0.016 | 0.021 | 0.41 | 0.53 | 1 |
| Øb2 | 0.016 | 0.024 | 0.41 | 0.61 | - |
| ØD | 0.335 | 0.375 | 8.51 | 9.40 | - |
| ØD1 | 0.305 | 0.335 | 7.75 | 8.51 | - |
| ØD2 | 0.110 | 0.160 | 2.79 | 4.06 | - |
| e | 0.200 BSC | | 5.08 BSC | | - |
| e1 | 0.100 BSC | | 2.54 BSC | | - |
| F | - | 0.040 | - | 1.02 | - |
| k | 0.027 | 0.034 | 0.69 | 0.86 | - |
| k1 | 0.027 | 0.045 | 0.69 | 1.14 | 2 |
| L | 0.500 | 0.750 | 12.70 | 19.05 | 1 |
| L1 | - | 0.050 | - | 1.27 | 1 |
| L2 | 0.250 | - | 6.35 | - | 1 |
| Q | 0.010 | 0.045 | 0.25 | 1.14 | - |
| $\alpha$ | $45^o$ BSC | | $45^o$ BSC | | 3 |
| $\beta$ | $45^o$ BSC | | $45^o$ BSC | | 3 |
| N | 8 | | 8 | | 4 |

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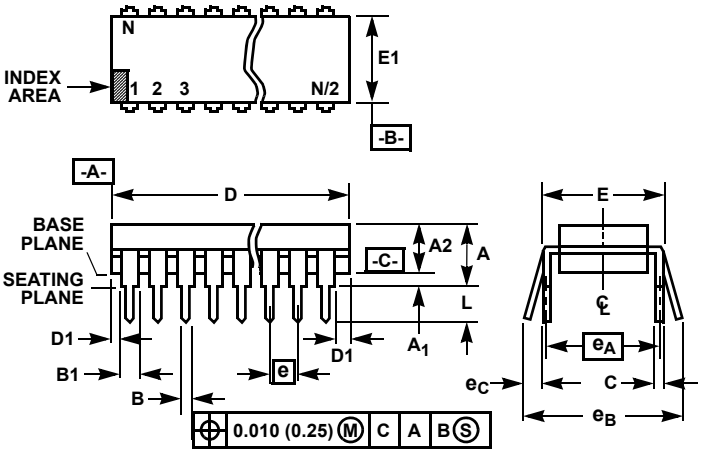
## *Dual-In-Line Plastic Packages (PDIP)*




NOTES:

1. Controlling Dimensions: INCH. In case of conflict between English and Metric dimensions, the inch dimensions control.
2. Dimensioning and tolerancing per ANSI Y14.5M-1982.
3. Symbols are defined in the "MO Series Symbol List" in Section 2.2 of Publication No. 95.
4. Dimensions A, A1 and L are measured with the package seated in JEDEC seating plane gauge GS-3.
5. D, D1, and E1 dimensions do not include mold flash or protrusions. Mold flash or protrusions shall not exceed 0.010 inch (0.25mm).
6. E and $e_A$ are measured with the leads constrained to be perpendicular to datum -C-.
7. $e_B$ and $e_C$ are measured at the lead tips with the leads unconstrained. $e_C$ must be zero or greater.
8. B1 maximum dimensions do not include dambar protrusions. Dambar protrusions shall not exceed 0.010 inch (0.25mm).
9. N is the maximum number of terminal positions.
10. Corner leads (1, N, N/2 and N/2 + 1) for E8.3, E16.3, E18.3, E28.3, E42.6 will have a B1 dimension of 0.030 - 0.045 inch (0.76 - 1.14mm).

**E8.3 (JEDEC MS-001-BA ISSUE D)**
**8 LEAD DUAL-IN-LINE PLASTIC PACKAGE**

| SYMBOL | INCHES | | MILLIMETERS | | NOTES |
|---|---|---|---|---|---|
| | MIN | MAX | MIN | MAX | |
| A | - | 0.210 | - | 5.33 | 4 |
| A1 | 0.015 | - | 0.39 | - | 4 |
| A2 | 0.115 | 0.195 | 2.93 | 4.95 | - |
| B | 0.014 | 0.022 | 0.356 | 0.558 | - |
| B1 | 0.045 | 0.070 | 1.15 | 1.77 | 8, 10 |
| C | 0.008 | 0.014 | 0.204 | 0.355 | - |
| D | 0.355 | 0.400 | 9.01 | 10.16 | 5 |
| D1 | 0.005 | - | 0.13 | - | 5 |
| E | 0.300 | 0.325 | 7.62 | 8.25 | 6 |
| E1 | 0.240 | 0.280 | 6.10 | 7.11 | 5 |
| e | 0.100 BSC | | 2.54 BSC | | - |
| $e_A$ | 0.300 BSC | | 7.62 BSC | | 6 |
| $e_B$ | - | 0.430 | - | 10.92 | 7 |
| L | 0.115 | 0.150 | 2.93 | 3.81 | 4 |
| N | 8 | | 8 | | 9 |

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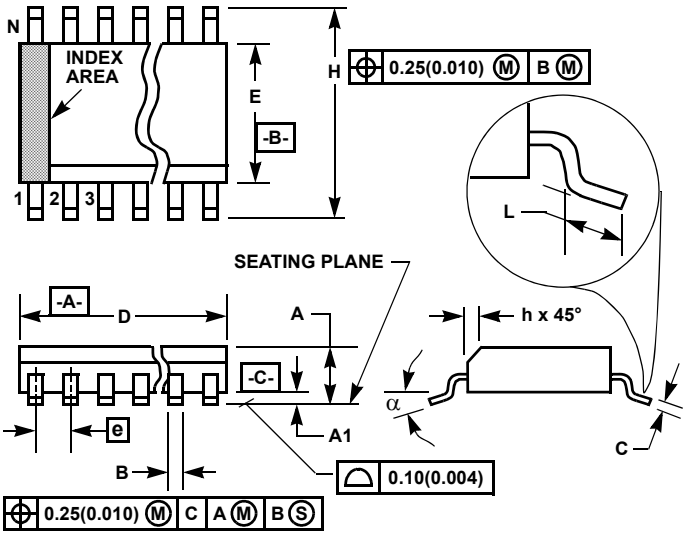
## *Small Outline Plastic Packages (SOIC)*




NOTES:

1. Symbols are defined in the “MO Series Symbol List” in Section 2.2 of Publication Number 95.
2. Dimensioning and tolerancing per ANSI Y14.5M-1982.
3. Dimension “D” does not include mold flash, protrusions or gate burrs. Mold flash, protrusion and gate burrs shall not exceed 0.15mm (0.006 inch) per side.
4. Dimension “E” does not include interlead flash or protrusions. Interlead flash and protrusions shall not exceed 0.25mm (0.010 inch) per side.
5. The chamfer on the body is optional. If it is not present, a visual index feature must be located within the crosshatched area.
6. “L” is the length of terminal for soldering to a substrate.
7. “N” is the number of terminal positions.
8. Terminal numbers are shown for reference only.
9. The lead width “B”, as measured 0.36mm (0.014 inch) or greater above the seating plane, shall not exceed a maximum value of 0.61mm (0.024 inch).
10. Controlling dimension: MILLIMETER. Converted inch dimensions are not necessarily exact.

**M8.15 (JEDEC MS-012-AA ISSUE C)**
**8 LEAD NARROW BODY SMALL OUTLINE PLASTIC PACKAGE**

| SYMBOL | INCHES | | MILLIMETERS | | NOTES |
|---|---|---|---|---|---|
| | MIN | MAX | MIN | MAX | |
| A | 0.0532 | 0.0688 | 1.35 | 1.75 | - |
| A1 | 0.0040 | 0.0098 | 0.10 | 0.25 | - |
| B | 0.013 | 0.020 | 0.33 | 0.51 | 9 |
| C | 0.0075 | 0.0098 | 0.19 | 0.25 | - |
| D | 0.1890 | 0.1968 | 4.80 | 5.00 | 3 |
| E | 0.1497 | 0.1574 | 3.80 | 4.00 | 4 |
| e | 0.050 BSC | | 1.27 BSC | | - |
| H | 0.2284 | 0.2440 | 5.80 | 6.20 | - |
| h | 0.0099 | 0.0196 | 0.25 | 0.50 | 5 |
| L | 0.016 | 0.050 | 0.40 | 1.27 | 6 |
| N | 8 | | 8 | | 7 |
| α | 0° | 8° | 0° | 8° | - |

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