

HA-2640, HA-2645

4MHz, High Supply Voltage Operational Amplifiers

FN2904  
Rev 6.00  
August 7, 2015

HA-2640 and HA-2645 are monolithic operational amplifiers which are designed to deliver unprecedented dynamic specifications for a high voltage internally compensated device. These dielectrically isolated devices offer very low values for offset voltage and offset current coupled with large output voltage swing and common mode input voltage.

For maximum reliability, these amplifiers offer unconditional output overload protection through current limiting and a chip temperature sensing circuit. This sensing device turns the amplifier "off", when the chip reaches a certain temperature level.

These amplifiers deliver  $\pm 35V$  common mode input voltage range,  $\pm 35V$  output voltage swing, and up to  $\pm 40V$  supply range for use in such designs as regulators, power supplies, and industrial control systems. 4MHz gain bandwidth and  $5V/\mu s$  slew rate make these devices excellent components for high performance signal conditioning applications. Outstanding input and output voltage swings coupled with a low 5nA offset current make these amplifiers excitation designs.

**Features**

- Output Voltage Swing . . . . .  $\pm 35V$
- Supply Voltage . . . . .  $\pm 10V$  to  $\pm 40V$
- Offset Current. . . . . 5nA
- Bandwidth . . . . . 4MHz
- Slew Rate. . . . .  $5V/\mu s$
- Common Mode Input Voltage Range. . . . .  $\pm 35V$
- Output Overload Protection

**Applications**

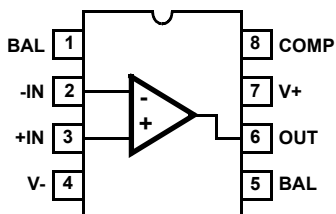
- Industrial Control Systems
- Power Supplies
- High Voltage Regulators
- Resolver Excitation
- Signal Conditioning

**Ordering Information**

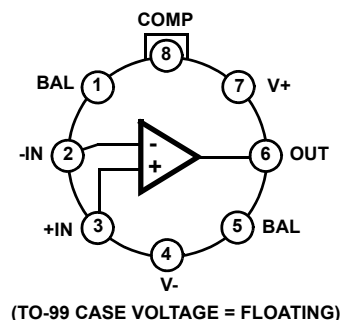
| PART NUMBER                                   | PART MARKING | TEMP. RANGE (°C) | PACKAGE         | PKG. DWG. # |
|---|--------------|------------------|-----------------|-------------|
| HA2-2640-2                                    | HA2-2640-2   | -55 to 125       | 8 Pin Metal Can | T8.C        |
| HA7-2640-2                                    | HA7-2640-2   | -55 to 125       | 8 Ld CERDIP     | F8.3A       |
| HA2-2645-5 (No longer available or supported) | HA2-2645-5   | 0 to 75          | 8 Pin Metal Can | T8.C        |
| HA7-2645-5 (No longer available or supported) | HA7-2645-5   | 0 to 75          | 8 Ld CERDIP     | F8.3A       |

**Pinouts**

HA-2640/2645  
(CERDIP)  
TOP VIEW



HA-2640/2645  
(METAL CAN)  
TOP VIEW



**Absolute Maximum Ratings**

Voltage Between V+ and V- Terminals ..... 100V  
 Differential Input Voltage Range ..... 37V  
 Output Current ..... Full Short Circuit Protection

**Operating Conditions**

Temperature Range  
 HA-2640-2 ..... -55°C to 125°C  
 HA-2645-5 ..... 0°C to 75°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 an evaluation PC board in free air.

**Thermal Information**

Thermal Resistance (Typical, Note 1)  $\theta_{JA}$  (°C/W)  $\theta_{JC}$  (°C/W)  
 CERDIP Package ..... 135 50  
 Metal Can Package ..... 165 80  
 Maximum Junction Temperature ..... 175°C  
 Maximum Storage Temperature Range ..... -65°C to 150°C  
 Maximum Lead Temperature (Soldering 10s) ..... 300°C

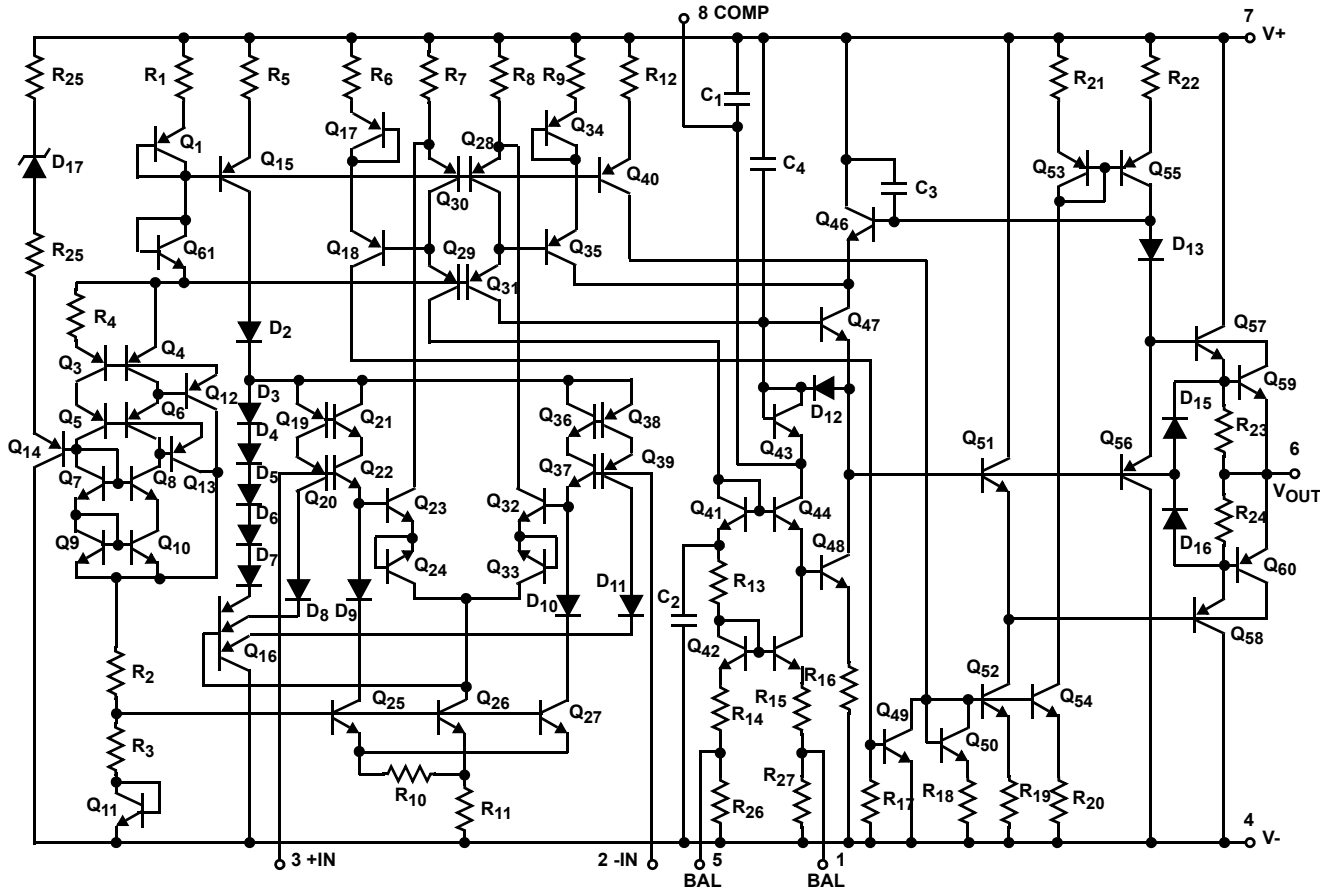
**Electrical Specifications**  $V_{SUPPLY} = \pm 40V$ ,  $R_L = 5k\Omega$ , Unless Otherwise Specified

| PARAMETER  | TEST CONDITIONS              | TEMP (°C) | HA-2640-2 |          |          | HA-2645-5 |          |          | UNITS            |
|--|------------------------------|-----------|-----------|----------|----------|-----------|----------|----------|------------------|
|  |                              |           | MIN       | TYP      | MAX      | MIN       | TYP      | MAX      |                  |
| <b>INPUT CHARACTERISTICS</b>   |                              |           |           |          |          |           |          |          |                  |
| Offset Voltage   |                              | 25        | -         | 2        | 4        | -         | 2        | 6        | mV               |
|  |                              | Full      |           | -        | 6        | -         | -        | 7        | mV               |
| Average Offset Voltage Drift   |                              | Full      | -         | 15       | -        | -         | 15       | -        | $\mu V/^\circ C$ |
| Bias Current   |                              | 25        | -         | 10       | 25       | -         | 12       | 30       | nA               |
|  |                              | Full      | -         | -        | 50       | -         | -        | 50       | nA               |
| Offset Current   |                              | 25        | -         | 5        | 12       | -         | 15       | 30       | nA               |
|  |                              | Full      | -         | -        | 35       | -         | -        | 50       | nA               |
| Input Resistance (Note 2)  |                              | 25        | 50        | 250      | -        | 40        | 200      | -        | M $\Omega$       |
| Common Mode Range  |                              | Full      | $\pm 35$  | -        | -        | $\pm 35$  | -        | -        | V                |
| <b>TRANSFER CHARACTERISTICS</b>  |                              |           |           |          |          |           |          |          |                  |
| Large Signal Voltage Gain  | $V_{OUT} = \pm 30V$          | 25        | 100       | 200      | -        | 100       | 200      | -        | kV/V             |
|  |                              | Full      | 75        | -        | -        | 75        | -        | -        | -                |
| Common Mode Rejection Ratio  | $V_{CM} = \pm 20V$           | Full      | 80        | 100      | -        | 74        | 100      | -        | dB               |
| Minimum Stable Gain  |                              | 25        | 1         | -        | -        | 1         | -        | -        | V/V              |
| Unity Gain Bandwidth   | $V_{OUT} = 90mV$             | 25        | -         | 4        | -        | -         | 4        | -        | MHz              |
| <b>OUTPUT CHARACTERISTICS</b>  |                              |           |           |          |          |           |          |          |                  |
| Output Voltage Swing   |                              | Full      | $\pm 35$  | -        | -        | $\pm 35$  | -        | -        | V                |
| Output Current   | $R_L = 1k\Omega$             | 25        | $\pm 12$  | $\pm 15$ | -        | $\pm 10$  | $\pm 12$ | -        | mA               |
| Output Resistance  | Open Loop                    | 25        | -         | 500      | -        | -         | 500      | -        | $\Omega$         |
| Full Power Bandwidth (Note 3)  | $V_{OUT} = \pm 35V$          | 25        | -         | 23       | -        | -         | 23       | -        | kHz              |
| <b>TRANSIENT RESPONSE</b> $A_V = +1$ , $C_L = 50pF$ , $R_L = 5k\Omega$ |                              |           |           |          |          |           |          |          |                  |
| Rise Time  | $V_{OUT} = \pm 200mV$        | 25        | -         | 60       | 135      | -         | 60       | 135      | ns               |
| Overshoot  | $V_{OUT} = \pm 200mV$        | 25        | -         | 15       | 30       |           | 15       | 40       | %                |
| Slew Rate  |                              | 25        | $\pm 3$   | $\pm 5$  | -        | $\pm 2.5$ | $\pm 5$  | -        | V/ $\mu s$       |
| <b>POWER SUPPLY CHARACTERISTICS</b>                                    |                              |           |           |          |          |           |          |          |                  |
| Supply Current   |                              | 25        | -         | 3.2      | 3.8      | -         | 3.2      | 4.5      | mA               |
| Supply Voltage Range   |                              | Full      | $\pm 10$  | -        | $\pm 40$ | $\pm 10$  | -        | $\pm 40$ | V                |
| Power Supply Rejection Ratio   | $V_S = \pm 10V$ to $\pm 40V$ | Full      | 80        | 90       | -        | 74        | 90       | -        | dB               |

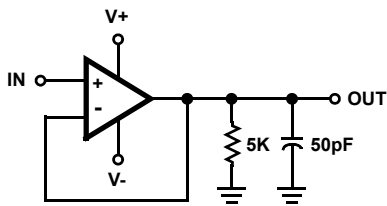
**NOTES:**

2. This parameter is based upon design calculations.
3. Full Power Bandwidth guaranteed based upon slew rate measurement:  $FPBW = S.R./2\pi V_{PEAK}$ ;  $V_{PEAK} = 35V$ .

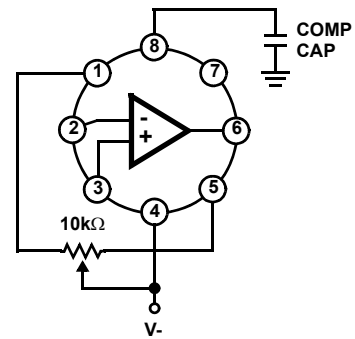
**Schematic Diagram**



**Test Circuits and Waveform**



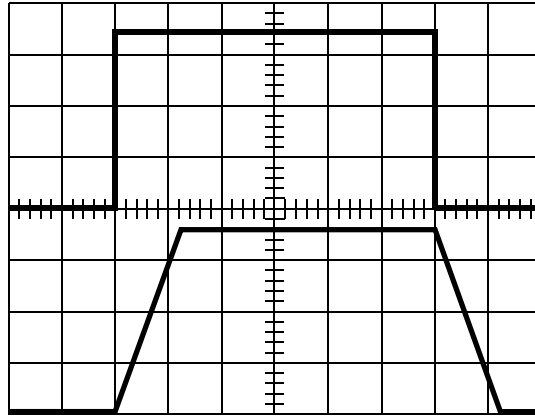
**FIGURE 1. SLEW RATE AND TRANSIENT RESPONSE TEST CIRCUIT**



NOTE: Tested offset adjustment range is  $|V_{OS} + 1mV|$  minimum referred to output. Typical range is  $\pm 20mV$  with  $R_T = 10k\Omega$ .

**FIGURE 2. SUGGESTED  $V_{OS}$  ADJUSTMENT AND COMPENSATION HOOK UP**

**Test Circuits and Waveform** (Continued)

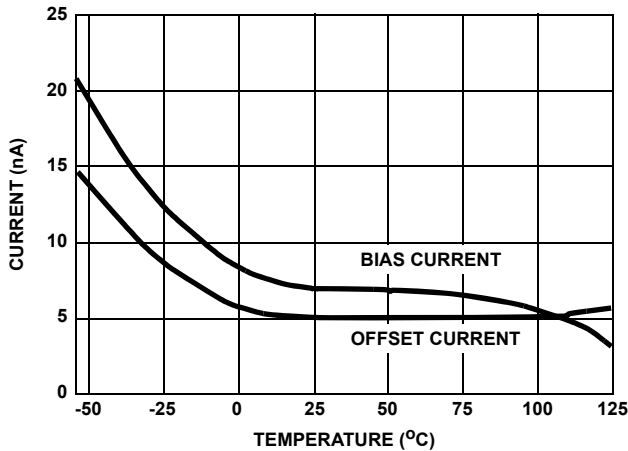


Vertical = 10V/Div., Horizontal = 5μs/Div.

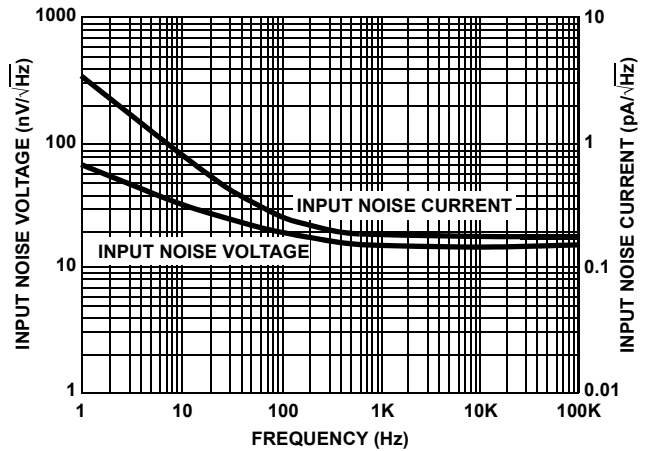
NOTE:  $R_L = 5k\Omega$ ,  $C_L = 50pF$ ,  $T_A = 25^\circ C$ ,  $V_S = \pm 40V$

**FIGURE 3. VOLTAGE FOLLOWER PULSE RESPONSE**

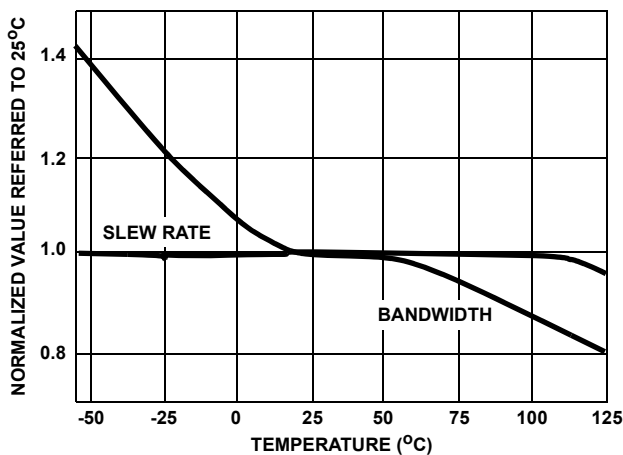
**Typical Performance Curves**  $V_S = \pm 40V$ ,  $T_A = 25^\circ C$ , Unless Otherwise Specified



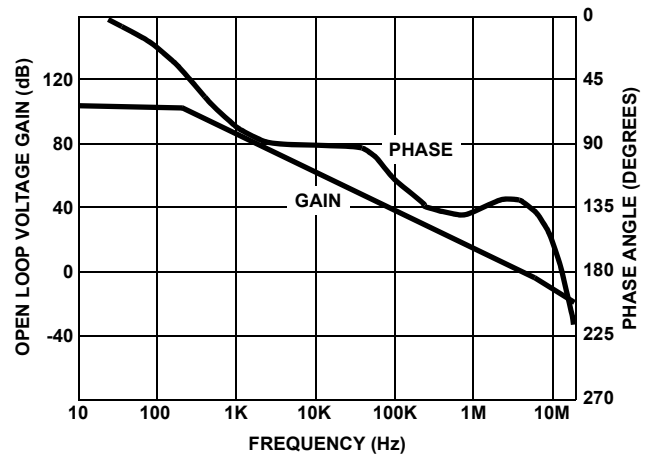
**FIGURE 4. INPUT BIAS AND OFFSET CURRENT vs TEMPERATURE**



**FIGURE 5. INPUT NOISE CHARACTERISTICS**



**FIGURE 6. NORMALIZED AC PARAMETERS vs TEMPERATURE**



**FIGURE 7. OPEN LOOP FREQUENCY RESPONSE**

**Typical Performance Curves**  $V_S = \pm 40V$ ,  $T_A = 25^\circ C$ , Unless Otherwise Specified (Continued)

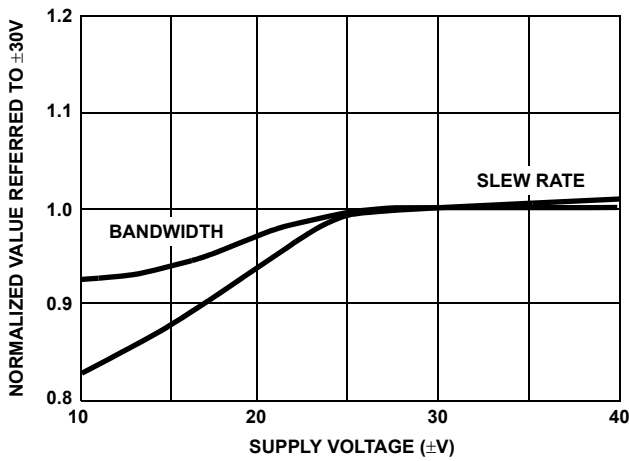


FIGURE 8. NORMALIZED AC PARAMETERS vs SUPPLY VOLTAGE AT 25°C

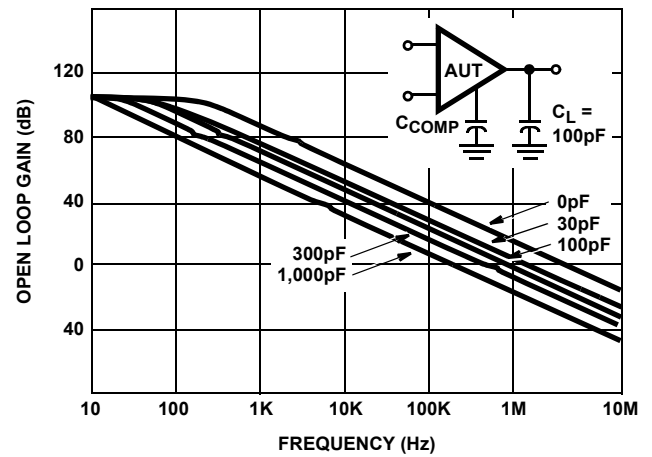


FIGURE 9. OPEN LOOP FREQUENCY RESPONSE FOR VARIOUS VALUES OF CAPACITORS FROM COMPENSATION PIN TO GROUND

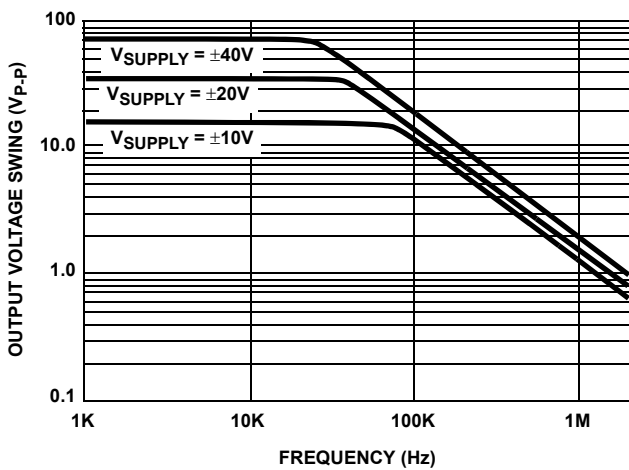


FIGURE 10. OUTPUT VOLTAGE SWING vs FREQUENCY

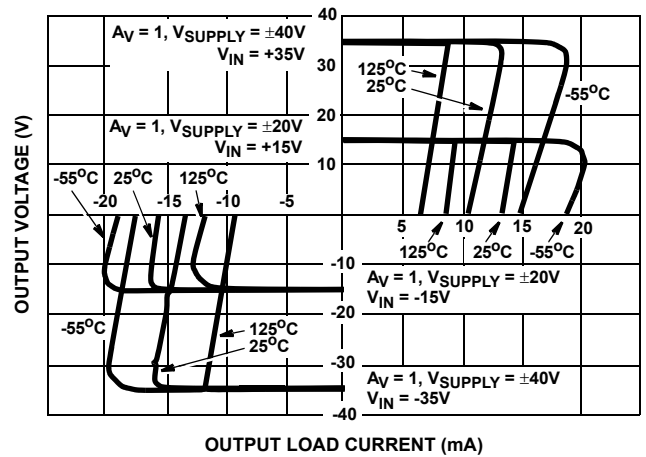


FIGURE 11. OUTPUT CURRENT CHARACTERISTIC

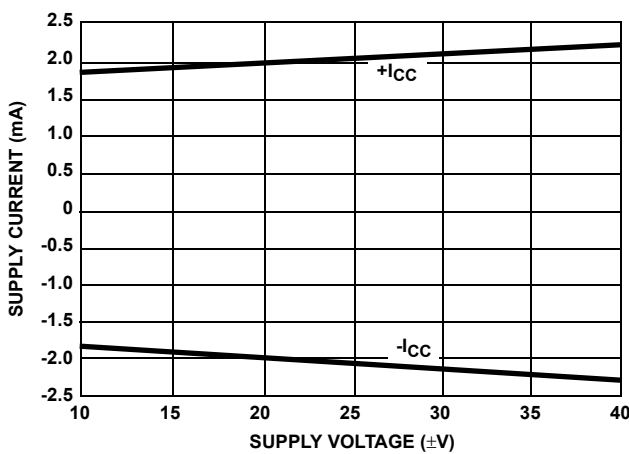


FIGURE 12. SUPPLY CURRENT vs SUPPLY VOLTAGE

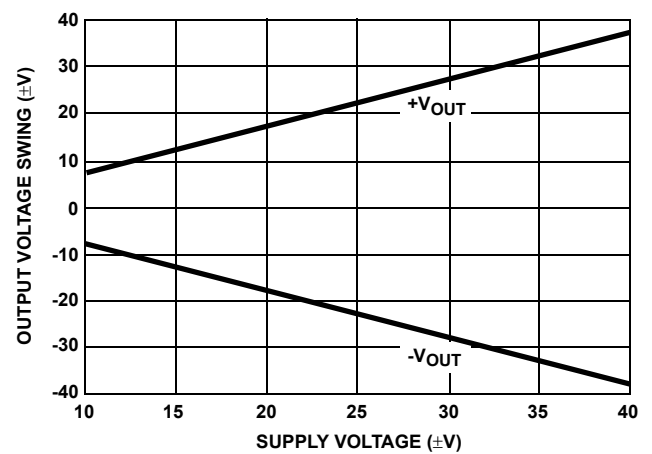


FIGURE 13. OUTPUT VOLTAGE SWING vs SUPPLY VOLTAGE

## Die Characteristics

### SUBSTRATE POTENTIAL (Powered Up):

Unbiased

### TRANSISTOR COUNT:

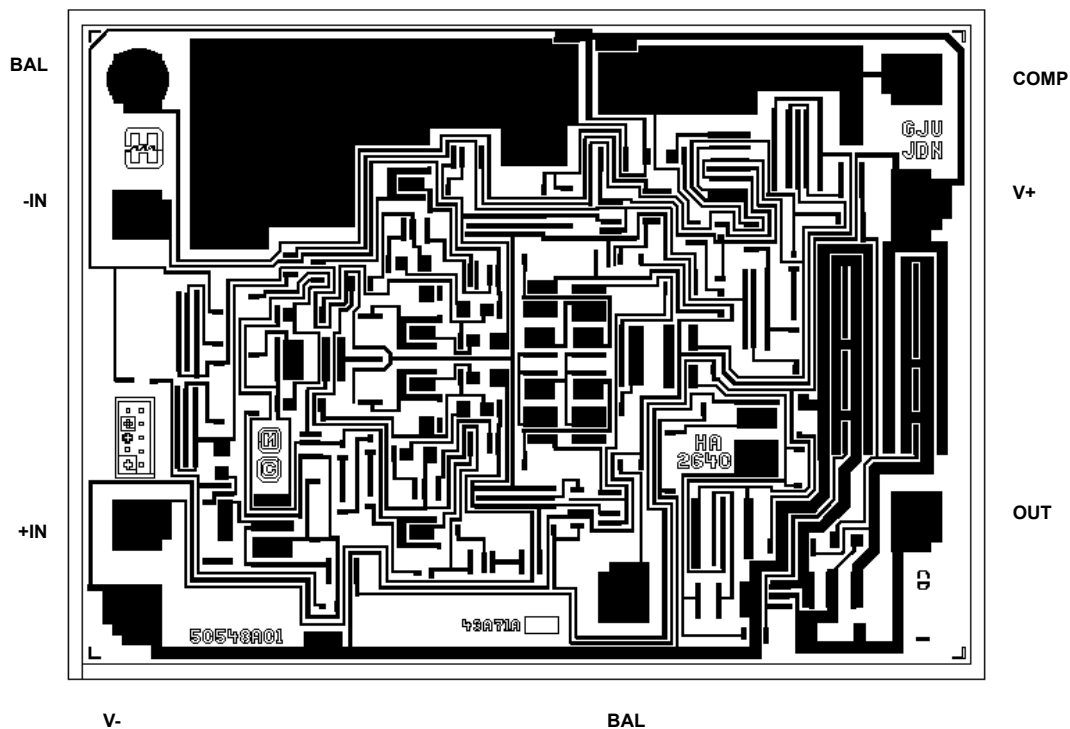
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### PROCESS:

HV200 Bipolar Dielectric Isolation

## Metallization Mask Layout

HA-2640, HA-2645



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## Revision History

The revision history provided is for informational purposes only and is believed to be accurate, but not warranted. Please go to the web to make sure that you have the latest revision.

| DATE           | REVISION | CHANGE  |
|----------------|----------|---|
| August 7, 2015 | FN2904.6 | Page 1, Ordering Information table: HA2-2645-5 and HA7-2645-5 no longer available or supported.<br>Added Revision History and About Intersil. |

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## About Intersil

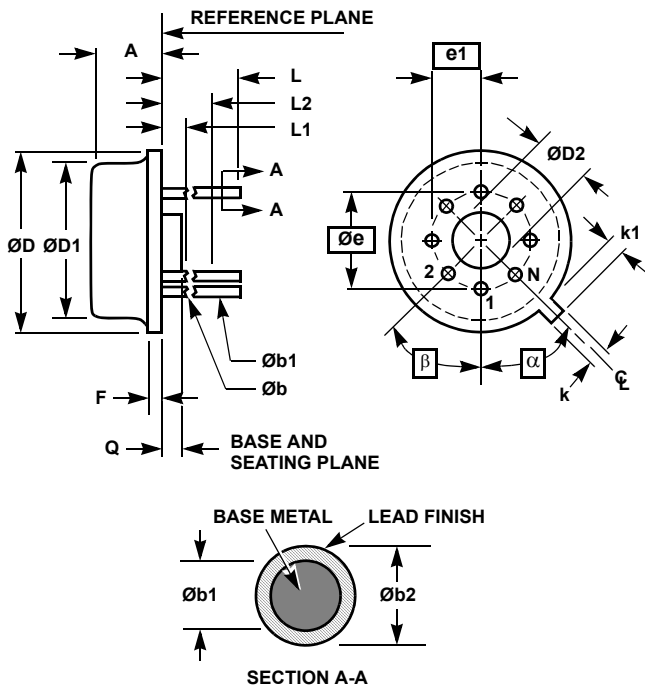
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**Metal Can Packages (Can)**



**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  | -     |
| $\varnothing b$  | 0.016     | 0.019 | 0.41        | 0.48  | 1     |
| $\varnothing b1$ | 0.016     | 0.021 | 0.41        | 0.53  | 1     |
| $\varnothing b2$ | 0.016     | 0.024 | 0.41        | 0.61  | -     |
| $\varnothing D$  | 0.335     | 0.375 | 8.51        | 9.40  | -     |
| $\varnothing D1$ | 0.305     | 0.335 | 7.75        | 8.51  | -     |
| $\varnothing D2$ | 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° BSC   |       | 45° BSC     |       | 3     |
| $\beta$          | 45° BSC   |       | 45° BSC     |       | 3     |
| N                | 8         |       | 8           |       | 4     |

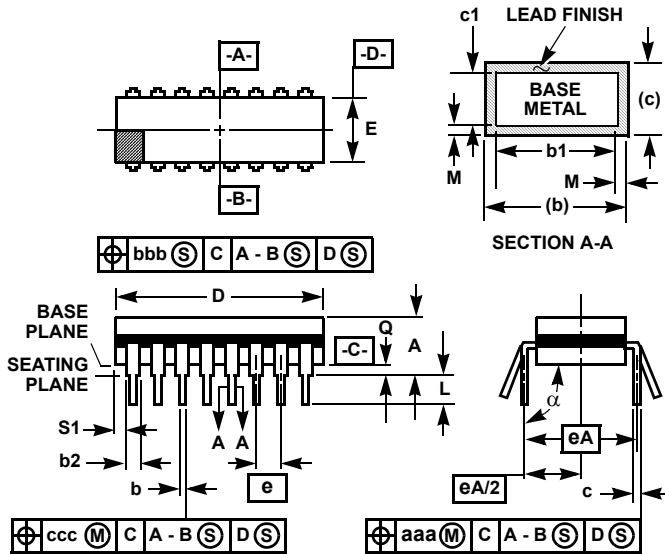
Rev. 0 5/18/94

**NOTES:**

1. (All leads)  $\varnothing b$  applies between L1 and L2.  $\varnothing b1$  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.



**Ceramic Dual-In-Line Frit Seal Packages (CERDIP)**



**F8.3A MIL-STD-1835 GDIP1-T8 (D-4, CONFIGURATION A)  
8 LEAD CERAMIC DUAL-IN-LINE FRIT SEAL PACKAGE**

| SYMBOL   | INCHES    |        | MILLIMETERS |       | NOTES |
|----------|-----------|--------|-------------|-------|-------|
|          | MIN       | MAX    | MIN         | MAX   |       |
| A        | -         | 0.200  | -           | 5.08  | -     |
| b        | 0.014     | 0.026  | 0.36        | 0.66  | 2     |
| b1       | 0.014     | 0.023  | 0.36        | 0.58  | 3     |
| b2       | 0.045     | 0.065  | 1.14        | 1.65  | -     |
| b3       | 0.023     | 0.045  | 0.58        | 1.14  | 4     |
| c        | 0.008     | 0.018  | 0.20        | 0.46  | 2     |
| c1       | 0.008     | 0.015  | 0.20        | 0.38  | 3     |
| D        | -         | 0.405  | -           | 10.29 | 5     |
| E        | 0.220     | 0.310  | 5.59        | 7.87  | 5     |
| e        | 0.100 BSC |        | 2.54 BSC    |       | -     |
| eA       | 0.300 BSC |        | 7.62 BSC    |       | -     |
| eA/2     | 0.150 BSC |        | 3.81 BSC    |       | -     |
| L        | 0.125     | 0.200  | 3.18        | 5.08  | -     |
| Q        | 0.015     | 0.060  | 0.38        | 1.52  | 6     |
| S1       | 0.005     | -      | 0.13        | -     | 7     |
| $\alpha$ | 90°       | 105°   | 90°         | 105°  | -     |
| aaa      | -         | 0.015  | -           | 0.38  | -     |
| bbb      | -         | 0.030  | -           | 0.76  | -     |
| ccc      | -         | 0.010  | -           | 0.25  | -     |
| M        | -         | 0.0015 | -           | 0.038 | 2, 3  |
| N        | 8         |        | 8           |       | 8     |

Rev. 0 4/94

**NOTES:**

1. Index area: A notch or a pin one identification mark shall be located adjacent to pin one and shall be located within the shaded area shown. The manufacturer's identification shall not be used as a pin one identification mark.
2. The maximum limits of lead dimensions b and c or M shall be measured at the centroid of the finished lead surfaces, when solder dip or tin plate lead finish is applied.
3. Dimensions b1 and c1 apply to lead base metal only. Dimension M applies to lead plating and finish thickness.
4. Corner leads (1, N, N/2, and N/2+1) may be configured with a partial lead paddle. For this configuration dimension b3 replaces dimension b2.
5. This dimension allows for off-center lid, meniscus, and glass overrun.
6. Dimension Q shall be measured from the seating plane to the base plane.
7. Measure dimension S1 at all four corners.
8. N is the maximum number of terminal positions.
9. Dimensioning and tolerancing per ANSI Y14.5M - 1982.
10. Controlling dimension: INCH

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