

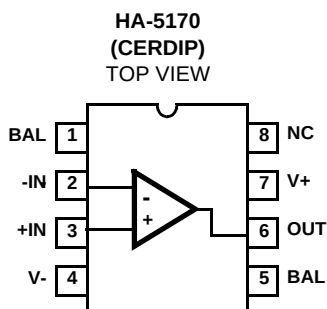
## 8MHz, Precision, JFET Input Operational Amplifier

The Intersil HA-5170 is a precision, JFET input, operational amplifier which features low noise, low offset voltage and low offset voltage drift. Constructed using FET/Bipolar technology, the Intersil Dielectric Isolation (DI) process, and laser trimming this amplifier offers low input bias and offset currents. This operational amplifier design also completely eliminates the troublesome errors due to warm-up drift.

Complementing these excellent input characteristics are dynamic performance characteristics never before available from precision operational amplifiers. An 8V/μs slew rate and 8MHz bandwidth allow the designer to extend precision instrumentation applications in both speed and bandwidth. These characteristics make the HA-5170 well suited for precision integrator amplifier designs.

The superior input characteristics also make the HA-5170 ideally suited for transducer signal amplifiers, precision voltage followers and precision data acquisition systems. For application assistance, please refer to Application Note AN540 addressing specifically this device.

## Pinout



## Features

- Low Offset Voltage . . . . . 100μV
- Low Offset Voltage Drift . . . . . 2μV/°C
- Low Noise . . . . . 10nV/√Hz
- High Open Loop Gain . . . . . 600kV/V
- Wide Bandwidth . . . . . 8MHz
- Unity Gain Stable

## Applications

- High Gain Instrumentation Amplifiers
- Precision Data Acquisition
- Precision Integrators
- Precision Threshold Detectors
- For Further Design Ideas, Refer to Application Note 540

## Part Number Information

| PART NUMBER | TEMP. RANGE (°C) | PACKAGE     | PKG. NO. |
|-------------|------------------|-------------|----------|
| HA7-5170-5  | 0 to 75          | 8 Ld CERDIP | F8.3A    |

### Absolute Maximum Ratings

Voltage Between V+ and V- Terminals ..... 44V  
 Differential Input Voltage ..... 30V  
 Output Short Circuit Duration ..... Indefinite

#### Operating Conditions

Temperature Range  
 HA-5170-5 ..... 0°C to 75°C

### Thermal Information

Thermal Resistance (Typical, Note 1)     $\theta_{JA}$  (°C/W)     $\theta_{JC}$  (°C/W)  
 CERDIP Package ..... 115    28  
 Maximum Junction Temperature ..... 175°C  
 Maximum Storage Temperature Range ..... -65°C to 150°C  
 Maximum Lead Temperature (Soldering 10s) ..... 300°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 a low effective thermal conductivity test board in free air. See Tech Brief TB379 for details.

### Electrical Specifications    $V_{SUPPLY} = \pm 15V$ , Unless Otherwise Specified

| PARAMETER                              | TEST<br>CONDITIONS | TEMP.<br>(°C) | HA-5170-5            |                      |     | UNITS                  |
|----------------------------------------|--------------------|---------------|----------------------|----------------------|-----|------------------------|
|                                        |                    |               | MIN                  | TYP                  | MAX |                        |
| INPUT CHARACTERISTICS                  |                    |               |                      |                      |     |                        |
| Offset Voltage                         |                    | 25            | -                    | 0.1                  | 0.3 | mV                     |
|                                        |                    | Full          | -                    | -                    | 0.5 | mV                     |
| Average Offset Voltage Drift (Note 3)  |                    | Full          | -                    | 2                    | 5   | μV/°C                  |
| Bias Current                           |                    | 25            | -                    | 20                   | 100 | pA                     |
|                                        |                    | Full          | -                    | 0.1                  | 2   | nA                     |
| Bias Current Average Drift             |                    | Full          | -                    | 3                    | -   | pA/°C                  |
| Offset Current                         |                    | 25            | -                    | 3                    | 60  | pA                     |
|                                        |                    | Full          | -                    | -                    | 0.1 | nA                     |
| Offset Current Average Drift (Note 3)  |                    | Full          | -                    | 0.3                  | 1   | pA/°C                  |
| Common Mode Range                      |                    | Full          | ±10                  | +15.1                | -   | V                      |
|                                        |                    | Full          | -                    | -12                  | -   | V                      |
| Differential Input Capacitance         |                    | 25            | -                    | 80                   | 100 | pF                     |
| Differential Input Resistance (Note 3) |                    | 25            | 1 x 10 <sup>10</sup> | 6 x 10 <sup>10</sup> | -   | Ω                      |
| Input Capacitance (Single Ended)       |                    | 25            | -                    | 12                   | -   | pF                     |
| Input Noise Voltage (Note 3)           | 0.1Hz to10Hz       | 25            | -                    | 0.5                  | 5   | μV <sub>P-P</sub>      |
| Input Noise Voltage Density (Note 3)   | f = 10Hz           | 25            | -                    | 20                   | 150 | nV/ $\sqrt{\text{Hz}}$ |
|                                        | f = 100Hz          | 25            | -                    | 12                   | 50  | nV/ $\sqrt{\text{Hz}}$ |
|                                        | f = 1000Hz         | 25            | -                    | 10                   | 25  | nV/ $\sqrt{\text{Hz}}$ |
| Input Noise Current Density (Note 3)   | f = 10Hz           | 25            | -                    | 0.05                 | -   | pA/ $\sqrt{\text{Hz}}$ |
|                                        | f = 100Hz          | 25            | -                    | 0.01                 | -   | pA/ $\sqrt{\text{Hz}}$ |
|                                        | f = 1000Hz         | 25            | -                    | 0.01                 | 0.1 | pA/ $\sqrt{\text{Hz}}$ |

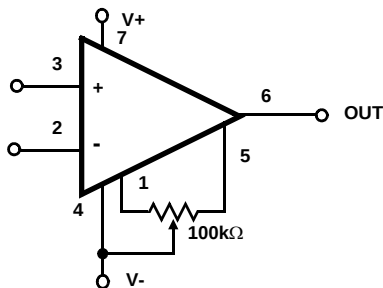
**Electrical Specifications**  $V_{SUPPLY} = \pm 15V$ , Unless Otherwise Specified (Continued)

| PARAMETER                             | TEST<br>CONDITIONS                               | TEMP.<br>(°C) | HA-5170-5 |     |     | UNITS |
|---------------------------------------|--------------------------------------------------|---------------|-----------|-----|-----|-------|
|                                       |                                                  |               | MIN       | TYP | MAX |       |
| TRANSFER CHARACTERISTICS              |                                                  |               |           |     |     |       |
| Large Signal Voltage Gain             | V <sub>OUT</sub> = ±10V,<br>R <sub>L</sub> = 2kΩ | 25            | 300       | 600 | -   | kV/V  |
|                                       |                                                  | Full          | 250       | -   | -   | kV/V  |
| Common Mode Rejection Ratio           | ΔV <sub>CM</sub> = ±10V                          | Full          | 90        | 100 | -   | dB    |
| Minimum Stable Gain                   |                                                  | 25            | 1         | -   | -   | V/V   |
| Closed Loop Bandwidth                 | A <sub>VCL</sub> = +1                            | 25            | 4         | 8   | -   | MHz   |
| OUTPUT CHARACTERISTICS                |                                                  |               |           |     |     |       |
| Output Voltage Swing                  | R <sub>L</sub> = 2kΩ                             | 25            | ±10       | ±12 | -   | V     |
| Full Power Bandwidth (Note 4)         | R <sub>L</sub> = 2kΩ                             | 25            | 80        | 120 | -   | kHz   |
| Output Current (Note 5)               | V <sub>OUT</sub> = ±10V                          | 25            | ±10       | ±15 | -   | mA    |
| Output Resistance (Note 3)            | Open Loop, 100Hz                                 | 25            | -         | 45  | 100 | Ω     |
| TRANSIENT RESPONSE                    |                                                  |               |           |     |     |       |
| Rise Time                             | Note 2                                           | 25            | -         | 45  | 100 | ns    |
| Slew Rate                             | Note 2                                           | 25            | 5         | 8   | -   | V/μs  |
| Settling Time (Notes 3, 6)            |                                                  | 25            | -         | 1   | 5   | μs    |
| POWER SUPPLY CHARACTERISTICS          |                                                  |               |           |     |     |       |
| Supply Current                        |                                                  | Full          | -         | 1.9 | 2.5 | mA    |
| Power Supply Rejection Ratio (Note 7) |                                                  | Full          | 90        | 105 | -   | dB    |

**NOTES:**

- See "Test Circuits and Waveforms" section.
- Parameter is not 100% tested. 90% of all units meet or exceed these specifications.
- Full power bandwidth guaranteed based on slew rate measurement using:  $FPBW = \frac{\text{Slew Rate}}{2\pi V_{PEAK}}$ .
- $I_{SC}$  turns on at  $\approx 23mA$ .
- Settling time is measured to 0.1% of final value for a 10V output step and  $A_V = -1$ .
- $V_+ = +15V$ ,  $V_- = -10V$  to  $-20V$  and  $V_- = -15V$ ,  $V_+ = +10V$  to  $+20V$ .

**Test Circuits and Waveforms**



Tested Offset Adjustment Range is  $|V_{OS} + 1mV|$  minimum referred to output. Typical range is  $\pm 5mV$  with  $R_T = 1k\Omega$  and  $\pm 15mV$  with  $R_T = 100k\Omega$ .

FIGURE 1.  $V_{OS}$  ADJUSTMENT

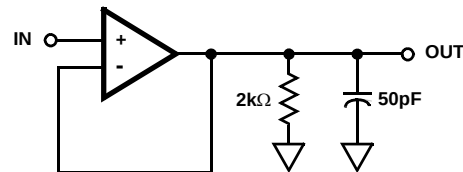
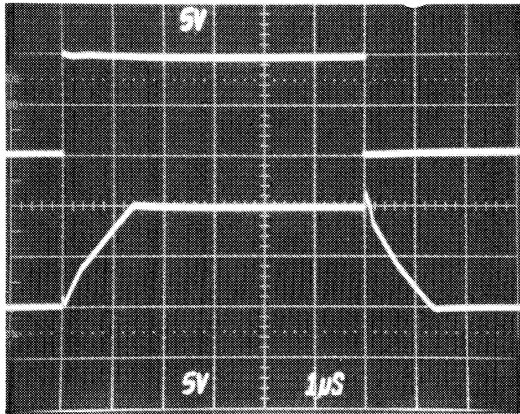


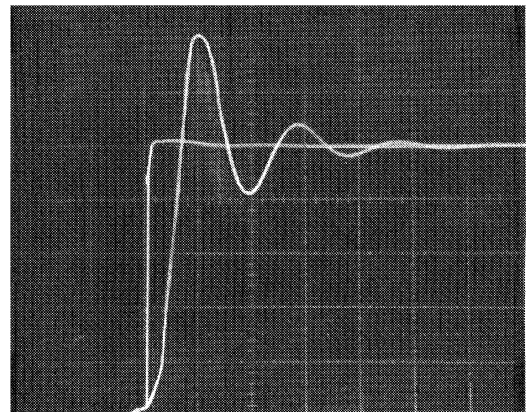
FIGURE 2. LARGE AND SMALL SIGNAL RESPONSE CIRCUIT

# Test Circuits and Waveforms (Continued)



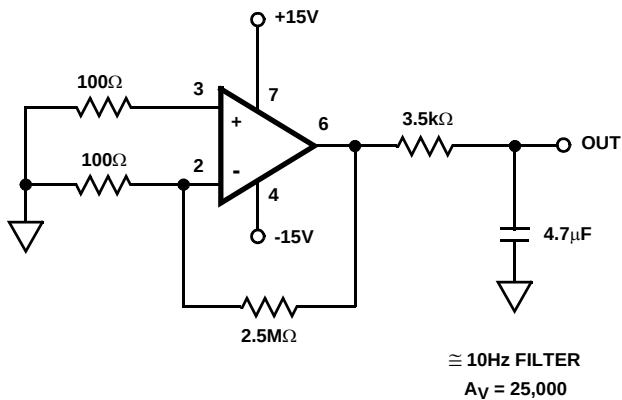
Vertical Scale: 5V/Div.  
Horizontal Scale: 1μs/Div.

**LARGE SIGNAL RESPONSE**

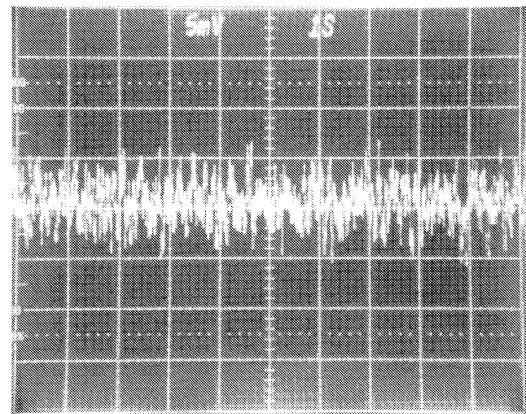


Vertical Scale: 10mV/Div.  
Horizontal Scale: 100ns/Div.

**SMALL SIGNAL RESPONSE**



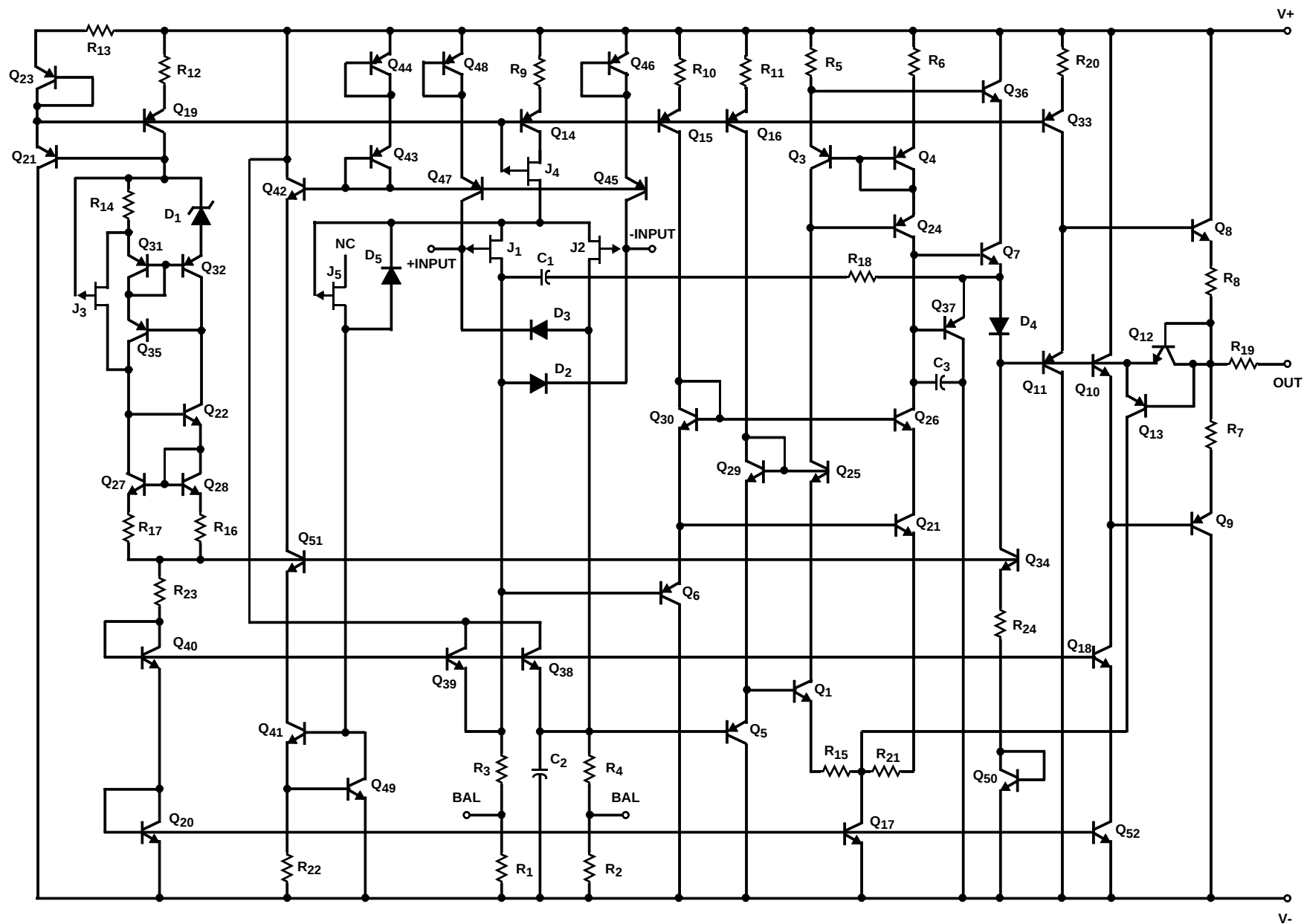
**FIGURE 3. LOW FREQUENCY NOISE TEST CIRCUIT**



Vertical Scale: 200nV/Div. (Noise Referred to Input)  
5mV/Div. at Output,  $A_{VCL} = 25,000$   
Horizontal Scale: 1s/Div.

**HA-5170 LOW FREQUENCY NOISE (0.1HZ TO 10HZ)**

# Schematic Diagram



HA-5170

## Typical Performance Curves

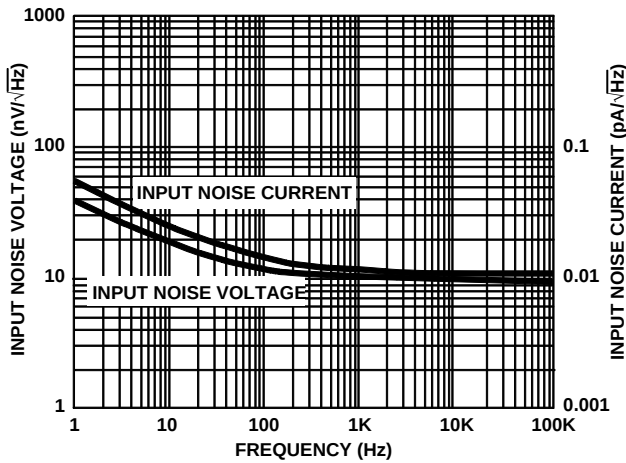


FIGURE 4. INPUT NOISE vs FREQUENCY

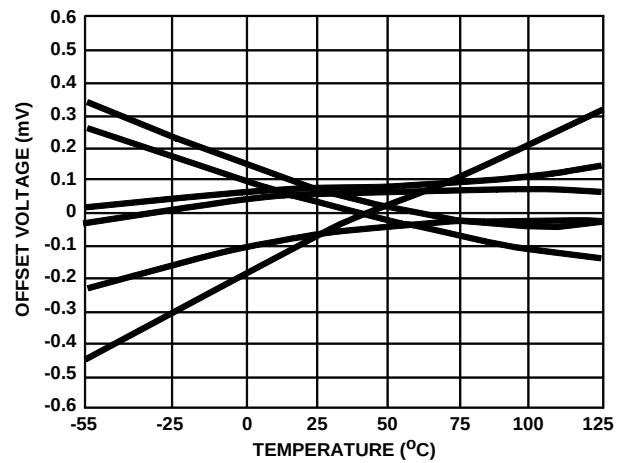


FIGURE 5. OFFSET VOLTAGE DRIFT vs TEMPERATURE OF REPRESENTATIVE UNITS

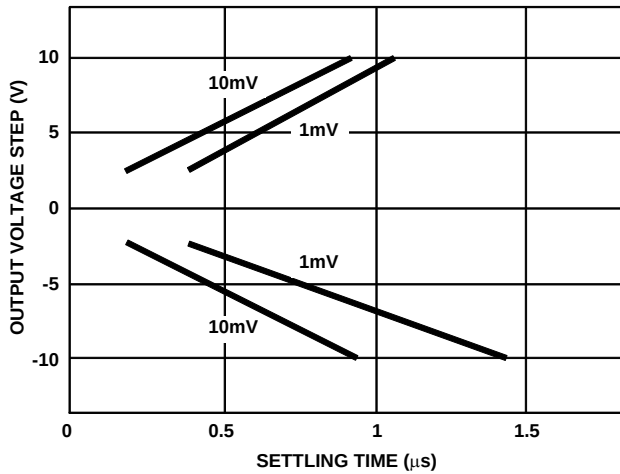


FIGURE 6. SETTLING TIME FOR VARIOUS OUTPUT STEP VOLTAGES

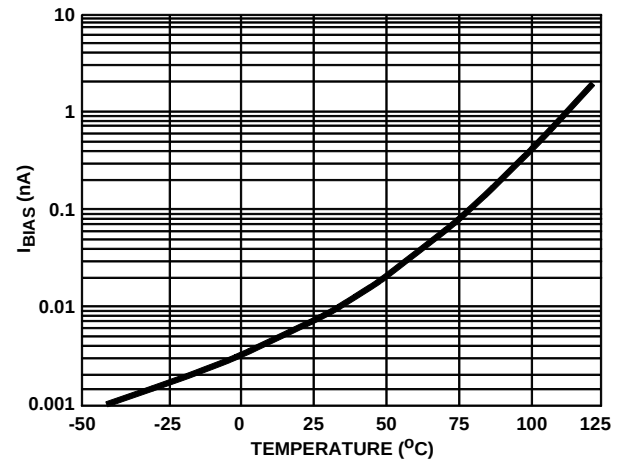


FIGURE 7. BIAS CURRENT vs TEMPERATURE

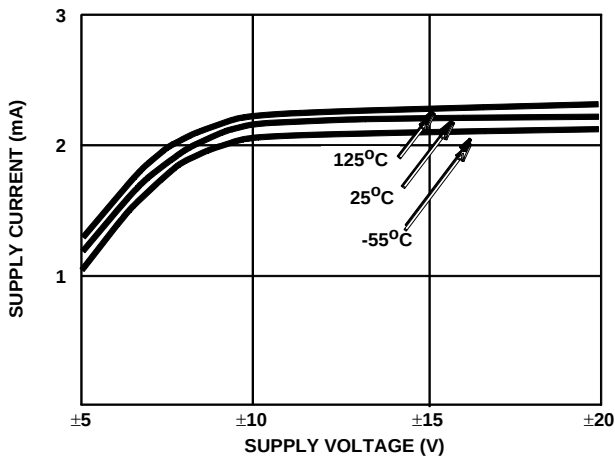


FIGURE 8. POWER SUPPLY CURRENT vs SUPPLY VOLTAGE

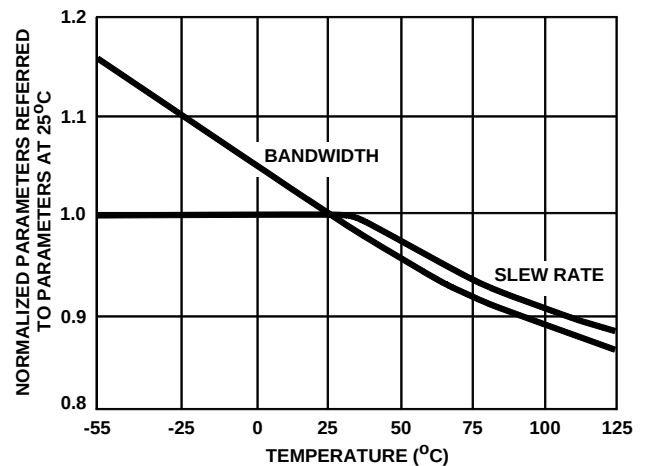


FIGURE 9. NORMALIZED AC PARAMETERS vs TEMPERATURE

Typical Performance Curves (Continued)

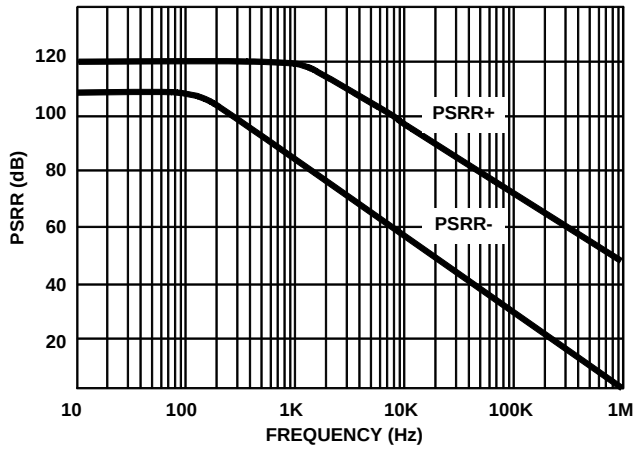


FIGURE 10. POWER SUPPLY REJECTION RATIO vs FREQUENCY

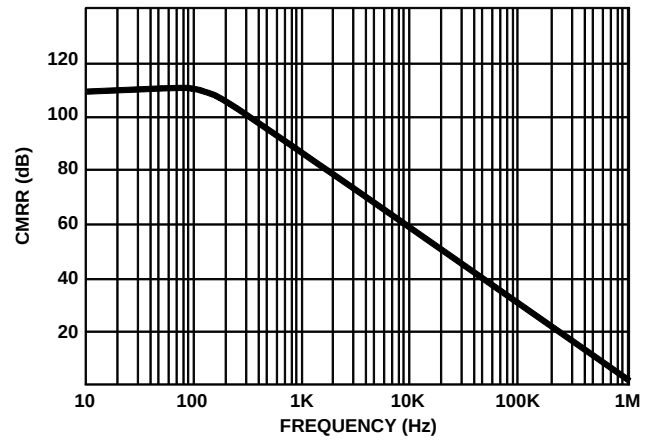


FIGURE 11. COMMON MODE REJECTION RATIO vs FREQUENCY

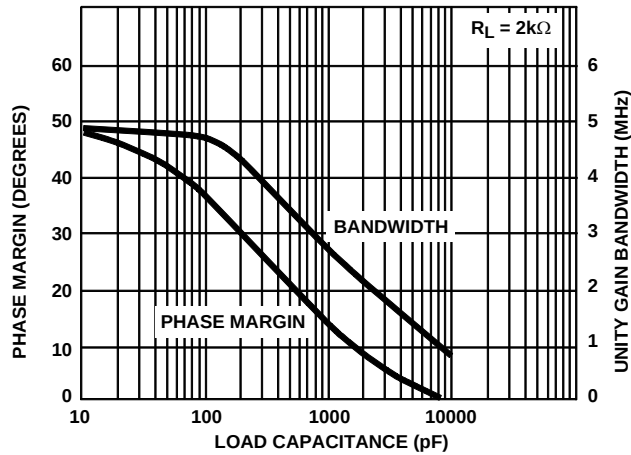


FIGURE 12. SMALL SIGNAL BANDWIDTH AND PHASE MARGIN vs LOAD CAPACITANCE

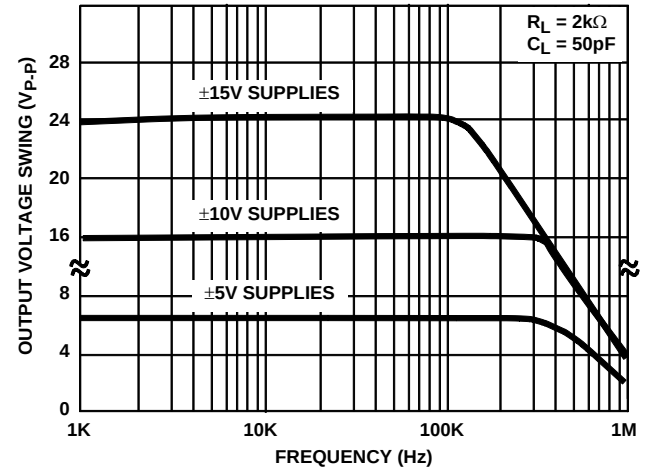


FIGURE 13. OUTPUT VOLTAGE SWING vs FREQUENCY AND SUPPLY VOLTAGE

## Typical Performance Curves (Continued)

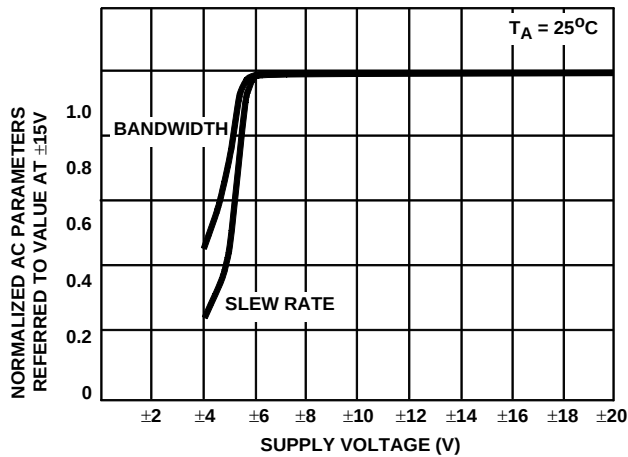


FIGURE 14. NORMALIZED AC PARAMETERS vs SUPPLY VOLTAGE

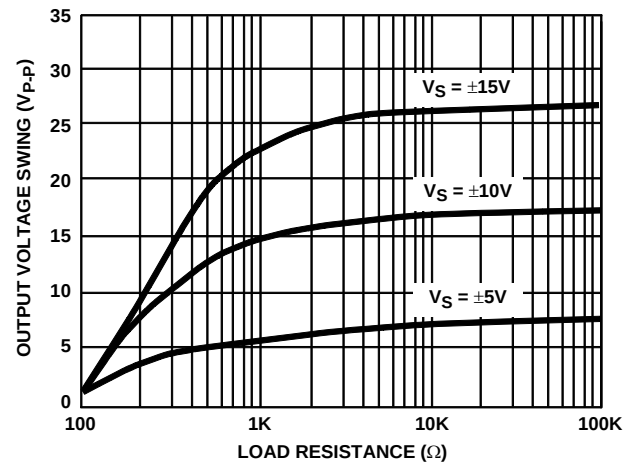


FIGURE 15. MAXIMUM OUTPUT VOLTAGE SWING vs LOAD RESISTANCE

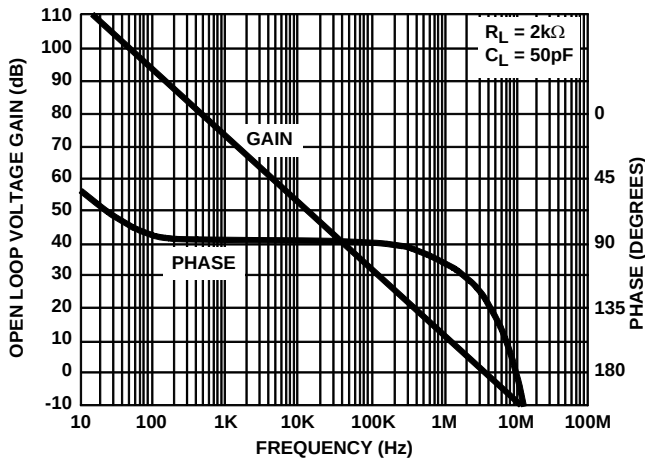


FIGURE 16. OPEN LOOP FREQUENCY RESPONSE

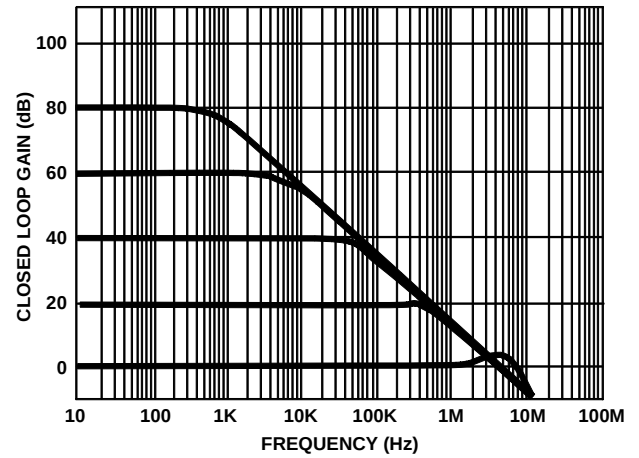
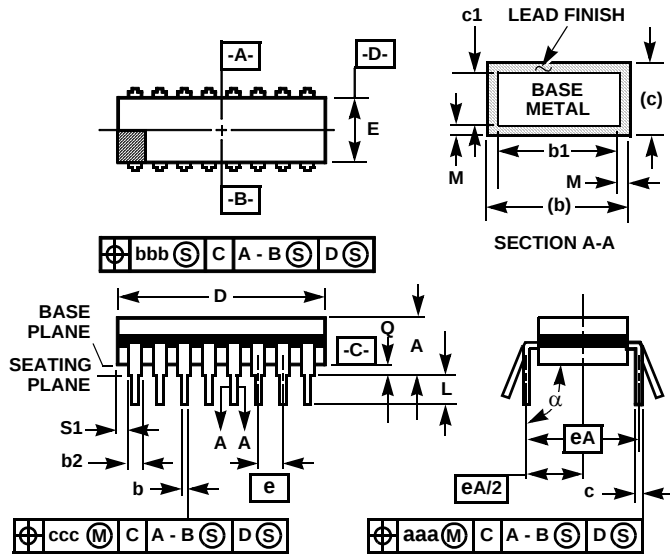


FIGURE 17. CLOSED LOOP FREQUENCY RESPONSE FOR VARIOUS CLOSED LOOP GAINS

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



### 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

### 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     |

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