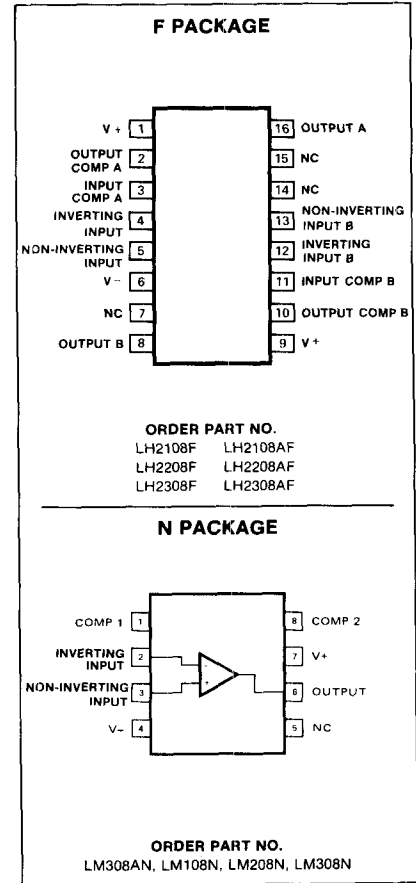
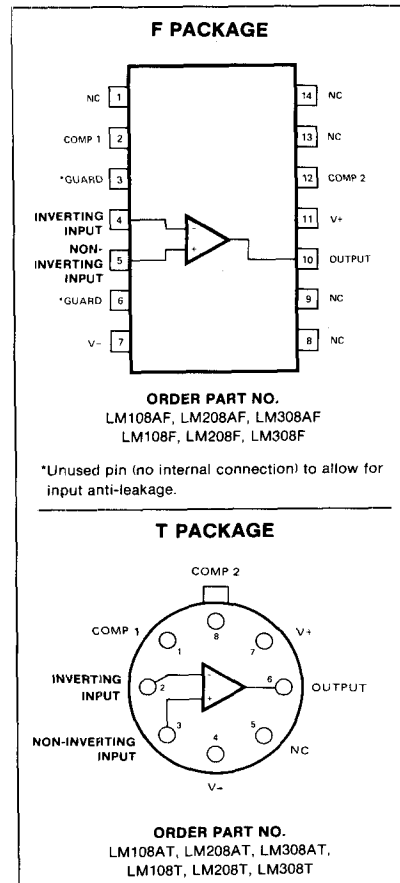


## DESCRIPTION

The LM108/108A series are precision operational amplifiers having specifications a factor of ten better than FET amplifiers over their operating temperature range. In addition to low input currents, these devices have extremely low offset voltage, making it possible in most cases, to eliminate offset adjustments.

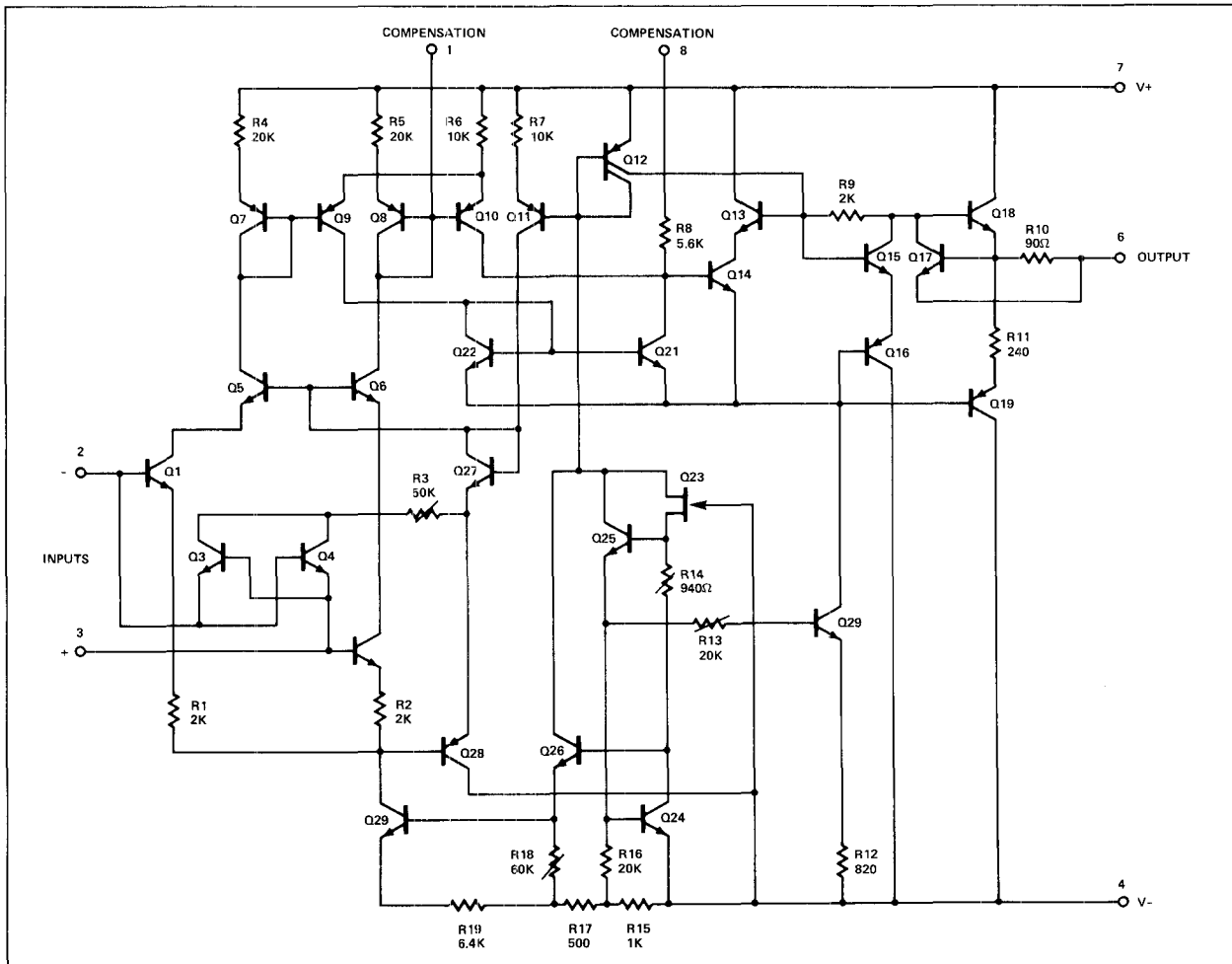
The LH2108 series are hybrids featuring two LM108A type dice in the same hermetic package. The electrical parameters are the same as the single amplifier.

## PIN CONFIGURATIONS



| FEATURES                                          | LM108/208                  | LM308           | LM108A/208A/308A           |
|---------------------------------------------------|----------------------------|-----------------|----------------------------|
| Maximum input bias current                        | 3.0nA over temp.           | 7.0nA           | 3.0nA over temp.           |
| Offset current                                    | Less than 400pA over temp. | Less than 1.0nA | Less than 400pA over temp. |
| Supply current (even in saturation)               | 300μA                      | 300μA           | 300μA                      |
| Guaranteed drift characteristics                  |                            |                 | 5μV/°C                     |
| Offset voltage guaranteed                         |                            |                 | Less than 0.5mV            |
| Low current error                                 |                            |                 |                            |
| LM108, 208, 308, 108A Mil std 883A, B,C available |                            |                 |                            |
| LM108A Mil std M38510 (JAN) planned               |                            |                 |                            |
| LH2108A series—military qualification pending     |                            |                 |                            |

# EQUIVALENT SCHEMATIC



## ABSOLUTE MAXIMUM RATINGS

| PARAMETER                               | RATING                                                      |                              | UNIT               |
|-----------------------------------------|-------------------------------------------------------------|------------------------------|--------------------|
|                                         | LH2108/LH2208<br>LH2108A/LH2208A<br>LM108A/208A/<br>108/208 | LM308A/308<br>LH2308A/LH2308 |                    |
| Supply voltage                          | $\pm 20$                                                    | $\pm 18$                     | V                  |
| Power dissipation <sup>1,4</sup>        | 500                                                         | 500                          | mW                 |
| Differential input current <sup>2</sup> | $\pm 10$                                                    | $\pm 10$                     | mA                 |
| Input voltage <sup>3</sup>              | $\pm 15$                                                    | $\pm 15$                     | V                  |
| Output short-circuit duration           | Continuous                                                  | Continuous                   |                    |
| Operating temperature range             |                                                             |                              |                    |
| LM108, LH2108                           | -55 to +125                                                 | 0 to +70                     | $^{\circ}\text{C}$ |
| LM208, LH2208                           | -25 to -85                                                  |                              | $^{\circ}\text{C}$ |
| Storage temperature range               | -65 to +150                                                 | -65 to +150                  | $^{\circ}\text{C}$ |
| Lead temperature (soldering 10sec)      | +300                                                        | +300                         | $^{\circ}\text{C}$ |

## NOTES

1. The maximum junction temperature of the LM108/108A is 150°C, while that of the LM208/208A is 100°C. For operating at elevated temperatures, devices in the TO-5 package must be derated based on a thermal resistance of 150°C/W, junction to ambient, or 45°C/W, junction to case. The thermal resistance of the dual-in-line package is 100°C/W, junction to ambient.
2. The inputs are shunted with back-to-back diodes for overvoltage protection. Therefore, excessive current will flow if a differential input voltage in excess of 1V is applied between the inputs unless some limiting resistance is used.
3. For supply voltages less than  $\pm 15V$ , the absolute maximum input voltage is equal to the supply voltage.
4. The maximum junction temperature of the LM308 is 85°C. For operation at elevated temperatures, devices in the TO-5 package must be derated based on a thermal resistance of 150°C/W, junction to ambient, or 45°C/W, junction to case. The thermal resistance of the dual-in-line package is 100°C/W, junction to ambient.

DC ELECTRICAL CHARACTERISTICS  $T_A = 25^\circ C, \pm 5V \leq V_S \leq \pm 20V$  unless otherwise specified.<sup>1,2</sup>

| PARAMETER                                                            | TEST CONDITIONS                                                                         | LM108/LH2108 |             |            | LM208/LH2208 |             |            | UNIT             |
|----------------------------------------------------------------------|-----------------------------------------------------------------------------------------|--------------|-------------|------------|--------------|-------------|------------|------------------|
|                                                                      |                                                                                         | Min          | Typ         | Max        | Min          | Typ         | Max        |                  |
| V <sub>OS</sub> Offset voltage                                       | $R_S \leq 10k\Omega$<br>$R_S \leq 10k\Omega$ , over temp.                               |              | .7          | 2.0<br>3.0 |              | 0.7         | 2.0<br>3.0 | mV<br>mV         |
| V <sub>OS</sub> Drift                                                | $R_S = 0\Omega$ , over temp.                                                            |              | 3.0         | 15         |              | 3.0         | 15         | $\mu V/^\circ C$ |
| I <sub>OS</sub> Offset current                                       | Over temp.                                                                              |              | 0.05        | 0.2<br>0.4 |              | 0.05        | 0.2<br>0.4 | nA<br>nA         |
| I <sub>OS</sub> Drift                                                | Over temp.                                                                              |              | 0.5         | 2.5        |              | 0.5         | 2.5        | $pA/^\circ C$    |
| I <sub>BIAS</sub> Input current                                      | Over temp.                                                                              |              | 0.8         | 2.0<br>3.0 |              | 0.8         | 2.0<br>3.0 | nA<br>nA         |
| V <sub>CM</sub> Common mode voltage range                            | Over temp.                                                                              | $\pm 13.5$   |             |            | $\pm 13.5$   |             |            | V                |
| CMRR Common mode rejection ratio                                     | $R_S \leq 10k\Omega$ , over temp.<br>$R_S \leq 10k\Omega, -25 \leq T_A \leq 85^\circ C$ | 85           | 100         |            | 85           | 100         |            | dB<br>dB         |
| R <sub>IN</sub> Input resistance                                     |                                                                                         | 30           | 70          |            | 30           | 70          |            | M $\Omega$       |
| V <sub>OUT</sub> Output voltage swing                                | $R_L = 10k\Omega$ , over temp.                                                          | $\pm 13$     | $\pm 14$    |            | $\pm 13$     | $\pm 14$    |            | V                |
| I <sub>CC</sub> Supply current                                       | $T_A = +125^\circ C$                                                                    |              | 0.3<br>0.15 |            | 0.6<br>0.4   | 0.3<br>0.15 | 0.6<br>0.4 | mA<br>mA         |
| PSRR Supply voltage rejection ratio                                  | $R_S \leq 10k\Omega$ , over temp.<br>$\pm 5V \leq V_S \leq \pm 15V$ , over temp.        | 80           | 96          |            | 80           | 96          |            | dB               |
| Average temperature Coefficient of input Offset voltage <sup>2</sup> | $\pm 5V \leq V_S \leq \pm 15V$ , over temp.                                             |              | 3.0         | 15         |              | 3.0         | 15         | $\mu V/^\circ C$ |
| Coefficient of input Offset current                                  | Over temp.<br>$\pm 5V \leq V_S \leq \pm 15V$                                            |              | 0.5         | 2.5        |              | 0.5         | 2.5        | $pA/^\circ C$    |

## NOTES

1. The maximum junction temperature of the LM1XX is 150°C, while that of the LM2XX is 200°C. For operating at elevated temperatures, devices must be derated based on the thermal resistance of the package as given in the package information section.
2. The LM108A has a guaranteed offset voltage less than 0.5mV at 25°C and 1.0mV for  $-55^\circ C \leq 125^\circ C$  and  $V_S = \pm 15V$ . The average temperature coefficient of input offset voltage is guaranteed to be less than  $5\mu V/^\circ C$  for these same conditions.

**DC ELECTRICAL CHARACTERISTICS** (Cont'd)  $T_A = 25^\circ\text{C}$ ,  $\pm 5\text{V} \leq V_S \leq \pm 20\text{V}$  unless otherwise specified.<sup>1,2</sup>

| PARAMETER                                                                                                            | TEST CONDITIONS                                                                         | LM308/LH2308     |          |     | LM108A/LH2108A |          |     | UNIT                         |
|----------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------|------------------|----------|-----|----------------|----------|-----|------------------------------|
|                                                                                                                      |                                                                                         | Min              | Typ      | Max | Min            | Typ      | Max |                              |
| V <sub>OS</sub> Offset voltage                                                                                       | $R_S \leq 10\text{k}\Omega$                                                             |                  |          |     |                | 0.3      | 0.5 | mV                           |
|                                                                                                                      | $R_S \leq 10\text{k}\Omega$ , over temp.                                                |                  |          |     |                |          | 1.0 | mV                           |
|                                                                                                                      | $R_S \leq 10\text{k}\Omega$ , $\pm 5\text{V} \leq V_S \leq \pm 15\text{V}$              |                  | 2.0      | 7.5 |                |          |     | mV                           |
|                                                                                                                      | $R_S \leq 10\text{k}\Omega$ , $\pm 5\text{V} \leq V_S \leq \pm 15\text{V}$ , over temp. |                  |          | 10  |                |          |     | mV                           |
| V <sub>OS</sub> Drift                                                                                                | $R_S = 0\Omega$ , over temp.                                                            |                  |          |     |                | 1.0      | 5.0 | $\mu\text{V}/^\circ\text{C}$ |
|                                                                                                                      | $R_S = 0\Omega$ , $\pm 5\text{V} \leq V_S \leq \pm 15\text{V}$ , over temp.             |                  |          | 10  |                |          |     | $\mu\text{V}/^\circ\text{C}$ |
| I <sub>OS</sub> Offset current                                                                                       | Over temp.                                                                              |                  |          |     |                | 0.05     | 0.2 | nA                           |
|                                                                                                                      | $\pm 5\text{V} \leq V_S \leq \pm 15\text{V}$                                            |                  | 0.2      | 1   |                |          | 0.4 | nA                           |
|                                                                                                                      | $\pm 5\text{V} \leq V_S \leq \pm 15\text{V}$ , over temp.                               |                  |          | 1.5 |                |          |     | nA                           |
|                                                                                                                      |                                                                                         |                  |          |     |                |          |     | nA                           |
| I <sub>OS</sub> Drift                                                                                                | Over temp.                                                                              |                  |          |     |                | 0.5      | 2.5 | $\text{pA}/^\circ\text{C}$   |
|                                                                                                                      | $\pm 5\text{V} \leq V_S \leq \pm 15\text{V}$ , over temp.                               |                  | 2.0      | 10  |                |          |     | $\text{pA}/^\circ\text{C}$   |
| I <sub>BIAS</sub> Input current                                                                                      | Over temp.                                                                              |                  |          |     |                | 0.8      | 2.0 | nA                           |
|                                                                                                                      | $\pm 5\text{V} \leq V_S \leq \pm 15\text{V}$                                            |                  | 1.5      | 7.0 |                |          | 3.0 | nA                           |
|                                                                                                                      | $V_S = \pm 15\text{V}$ , over temp.                                                     |                  |          | 10  |                |          |     | nA                           |
|                                                                                                                      |                                                                                         |                  |          |     |                |          |     | nA                           |
| V <sub>CM</sub> Common mode voltage range                                                                            | Over temp.                                                                              |                  |          |     | $\pm 13.5$     |          |     | V                            |
|                                                                                                                      | $\pm 5\text{V} \leq V_S \leq \pm 15\text{V}$ , over temp.                               | $\pm 14\text{V}$ |          |     |                |          |     | V                            |
| CMRR Common mode rejection ratio                                                                                     | $R_S \leq 10\text{k}\Omega$ , over temp.                                                |                  |          |     | 96             | 110      |     | dB                           |
|                                                                                                                      | $R_S \leq 10\text{k}\Omega$ , $\pm 5\text{V} \leq V_S \leq \pm 15\text{V}$ , over temp. | 80               | 100      |     |                |          |     | dB                           |
| R <sub>IN</sub> Input resistance                                                                                     |                                                                                         | 10               | 40       |     | 30             | 70       |     | M $\Omega$                   |
| V <sub>OUT</sub> Output voltage swing                                                                                | $R_L = 10\text{k}\Omega$ , over temp.                                                   |                  |          |     | $\pm 13$       | $\pm 14$ |     | V                            |
|                                                                                                                      | $\pm 5\text{V} \leq V_S \leq \pm 15\text{V}$ , over temp.                               | $\pm 13$         | $\pm 14$ |     |                |          |     | V                            |
| I <sub>CC</sub> Supply current                                                                                       |                                                                                         |                  |          |     |                | 0.3      | 0.6 | mA                           |
|                                                                                                                      | $T_A = +125^\circ\text{C}$                                                              |                  | 0.3      | 0.8 |                | 0.15     | 0.4 | mA                           |
|                                                                                                                      | $V_S = \pm 15\text{V}$                                                                  |                  |          |     |                |          |     | mA                           |
| P <sub>D</sub> Power consumption                                                                                     | $\pm 5\text{V} \leq V_S \leq \pm 15\text{V}$                                            |                  | 9.0      | 24  |                |          |     | mW                           |
| P <sub>SR</sub> Supply voltage rejection ratio                                                                       | $R_S \leq 10\text{k}\Omega$ , over temp.                                                |                  |          |     | 96             | 110      |     | dB                           |
|                                                                                                                      | $\pm 5\text{V} \leq V_S \leq \pm 15\text{V}$ , over temp.                               | 80               | 96       |     |                |          |     | dB                           |
| Average temperature<br>Coefficient of input<br>Offset voltage <sup>2</sup><br>Coefficient of input<br>Offset current | $\pm 5\text{V} \leq V_S \leq \pm 15\text{V}$ , over temp.                               |                  |          |     |                | 1.0      | 5.0 | $\mu\text{V}/^\circ\text{C}$ |
|                                                                                                                      |                                                                                         |                  | 6.0      | 30  |                |          |     | $\mu\text{V}/^\circ\text{C}$ |
|                                                                                                                      | Over temp.                                                                              |                  |          |     |                | 0.5      | 2.5 | $\mu\text{V}/^\circ\text{C}$ |
|                                                                                                                      | $\pm 5\text{V} \leq V_S \leq \pm 15\text{V}$                                            |                  | 2.0      | 10  |                |          |     | $\text{pA}/^\circ\text{C}$   |

## NOTES

1. The maximum junction temperature of the LM1XX is  $150^\circ\text{C}$ , while that of the LM2XX is  $200^\circ\text{C}$ . For operating at elevated temperatures, devices must be derated based on the thermal resistance of the package as given in the package information section.
2. The LM108A has a guaranteed offset voltage less than  $0.5\text{mV}$  at  $25^\circ\text{C}$  and  $1.0\text{mV}$  for  $-55^\circ\text{C} \leq 125^\circ\text{C}$  and  $V_S = \pm 15\text{V}$ . The average temperature coefficient of input offset voltage is guaranteed to be less than  $5\mu\text{V}/^\circ\text{C}$  for these same conditions.

**DC ELECTRICAL CHARACTERISTICS** (Cont'd)  $T_A = 25^\circ\text{C}$ ,  $\pm 5\text{V} \leq V_S \leq \pm 20\text{V}$  unless otherwise specified.<sup>1,2</sup>

| PARAMETER                                                                  | TEST CONDITIONS                                                                                                                                               | LM208A/LH2208A |             |            | LM308A/LH2308A |          |            | UNIT                                                         |
|----------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|-------------|------------|----------------|----------|------------|--------------------------------------------------------------|
|                                                                            |                                                                                                                                                               | Min            | Typ         | Max        | Min            | Typ      | Max        |                                                              |
| $V_{OS}$ Offset voltage                                                    | $R_S \leq 10\text{k}\Omega$<br>$R_S \leq 10\text{k}\Omega$ , over temp.                                                                                       |                | 0.3         | 0.5<br>1.0 |                | 0.3      | 0.5<br>.75 | mV<br>mV                                                     |
| $V_{OS}$ Drift                                                             | $R_S = 0\Omega$ , over temp.                                                                                                                                  |                | 1.0         | 5.0        |                | 1.0      | 5.0        | $\mu\text{V}/^\circ\text{C}$                                 |
| $I_{OS}$ Offset current                                                    | Over temp.                                                                                                                                                    |                | 0.05        | 0.2<br>0.4 |                |          | 1<br>1.5   | nA<br>nA                                                     |
| $I_{OS}$ Drift                                                             | Over temp.                                                                                                                                                    |                | 0.5         | 2.5        |                | 2.0      | 10         | $\text{pA}/^\circ\text{C}$                                   |
| $I_{BIAS}$ Input current                                                   | Over temp.                                                                                                                                                    |                | 0.8         | 2.0<br>3.0 |                | 1.5      | 7.0<br>10  | nA<br>nA                                                     |
| $V_{CM}$ Common mode voltage range                                         | Over temp.<br>$\pm 5\text{V} \leq V_S \leq \pm 15\text{V}$ , over temp.                                                                                       | $\pm 13.5$     |             |            | $\pm 14$       |          |            | V<br>V                                                       |
| CMRR Common mode rejection ratio                                           | $R_S \leq 10\text{k}\Omega$ , $-25 \leq T_A \leq 85^\circ\text{C}$<br>$R_S \leq 10\text{k}\Omega$ , $\pm 5\text{V} \leq V_S \leq \pm 15\text{V}$ , over temp. | 96             | 110         |            | 96             | 110      |            | dB<br>dB                                                     |
| $R_{IN}$ Input resistance                                                  | $R_S \leq 10\text{k}\Omega$ , $\pm 5\text{V} \leq V_S \leq \pm 15\text{V}$                                                                                    | 30             | 70          |            | 10             | 40       |            | M $\Omega$<br>M $\Omega$                                     |
| $V_{OUT}$ Output voltage swing                                             | $R_L = 10\text{k}\Omega$ , over temp.<br>$\pm 5\text{V} \leq V_S \leq \pm 15\text{V}$ , over temp.                                                            | $\pm 13$       | $\pm 14$    |            | $\pm 13$       | $\pm 14$ |            | V<br>V                                                       |
| $I_{CC}$ Supply current                                                    | $T_A = +125^\circ\text{C}$<br>$V_S = \pm 15\text{V}$                                                                                                          |                | 0.3<br>0.15 | 0.6<br>0.4 |                | 0.3      | 0.8        | mA<br>mA<br>mA                                               |
| $P_D$ Power consumption                                                    | $\pm 5\text{V} \leq V_S \leq \pm 15\text{V}$                                                                                                                  |                |             |            |                | 9.0      | 24         | mW                                                           |
| $P_{SRR}$ Supply voltage rejection ratio                                   | $R_S \leq 10\text{k}\Omega$ , over temp.<br>$\pm 5\text{V} \leq V_S \leq \pm 15\text{V}$ , over temp.                                                         | 96             | 110         |            | 96             | 110      |            | dB<br>dB                                                     |
| Average temperature<br>Coefficient of input<br>Offset voltage <sup>2</sup> | $\pm 5\text{V} \leq V_S \leq \pm 15\text{V}$ , over temp.                                                                                                     |                | 1.0         | 5.0        |                | 1.0      | 5.0        | $\mu\text{V}/^\circ\text{C}$<br>$\mu\text{V}/^\circ\text{C}$ |
| Coefficient of input<br>Offset current                                     | Over temp.<br>$\pm 5\text{V} \leq V_S \leq \pm 15\text{V}$                                                                                                    |                | 0.5         | 2.5        |                | 2.0      | 10         | $\text{pA}/^\circ\text{C}$<br>$\text{pA}/^\circ\text{C}$     |

## NOTES

1. The maximum junction temperature of the LM1XX is  $150^\circ\text{C}$ , while that of the LM2XX is  $200^\circ\text{C}$ . For operating at elevated temperatures, devices must be derated based on the thermal resistance of the package as given in the package information section.
2. The LM108A has a guaranteed offset voltage less than  $0.5\text{mV}$  at  $25^\circ\text{C}$  and  $1.0\text{mV}$  for  $-55^\circ\text{C} \leq 125^\circ\text{C}$  and  $V_S = \pm 15\text{V}$ . The average temperature coefficient of input offset voltage is guaranteed to be less than  $5\mu\text{V}/^\circ\text{C}$  for these same conditions.

**AC ELECTRICAL CHARACTERISTICS**  $T_A = 25^\circ\text{C}$ ,  $\pm 5\text{V} \leq V_S \leq \pm 20\text{V}$  unless otherwise specified.

| PARAMETER                                        | TEST CONDITIONS                                                                                                                       | LM108/LH2108 |     |     | LM208/LH2208 |     |     | LM308/LH2308 |     |     | UNIT |
|--------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|--------------|-----|-----|--------------|-----|-----|--------------|-----|-----|------|
|                                                  |                                                                                                                                       | Min          | Typ | Max | Min          | Typ | Max | Min          | Typ | Max |      |
| $A_{VOL}$ Large signal voltage gain <sup>1</sup> | $R_L \geq 10\text{k}\Omega$<br>Over temp.<br>$V_S = 15\text{V}$ , $V_{OUT} = \pm 10\text{V}$ ,<br>$R_L \geq 10\text{k}$<br>Over temp. | 50           | 300 |     | 50           | 300 |     |              |     |     | V/mV |
|                                                  |                                                                                                                                       | 25           |     |     | 25           |     |     |              |     |     | V/mV |
|                                                  |                                                                                                                                       |              |     |     |              |     |     | 25           | 300 |     | V/mV |
|                                                  |                                                                                                                                       |              |     |     |              |     |     | 15           |     |     | V/mV |

## NOTE

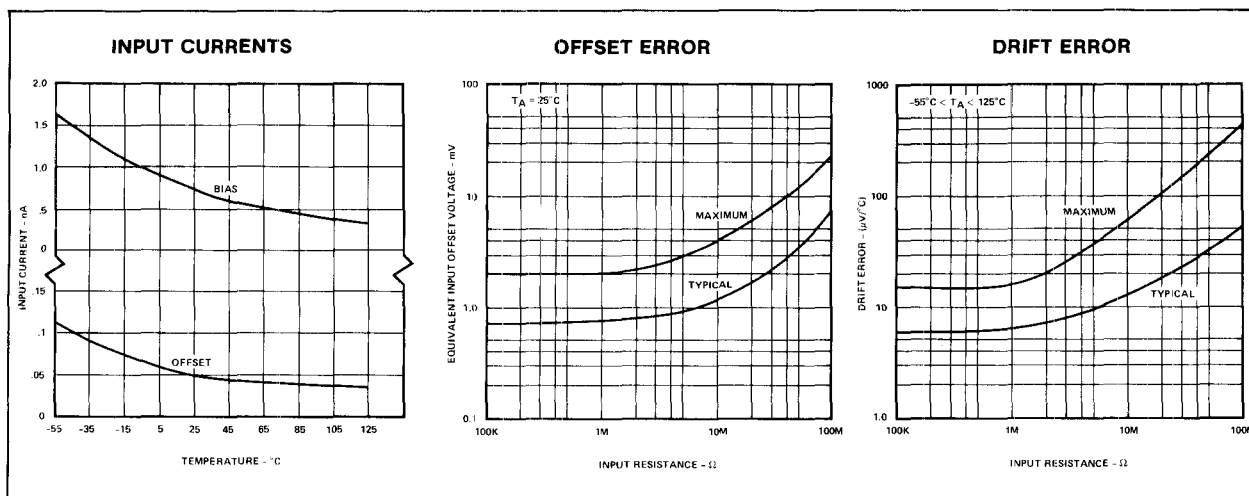
1. The maximum junction temperature of the LM1XX is  $150^\circ\text{C}$ , while that of the LM2XX is  $200^\circ\text{C}$ . For operating at elevated temperatures, devices must be derated based on the thermal resistance of the package as given in the package information section.

**AC ELECTRICAL CHARACTERISTICS** (Cont'd)  $T_A = 25^\circ\text{C}$ ,  $\pm 5\text{V} \leq V_S \leq \pm 20\text{V}$  unless otherwise specified.

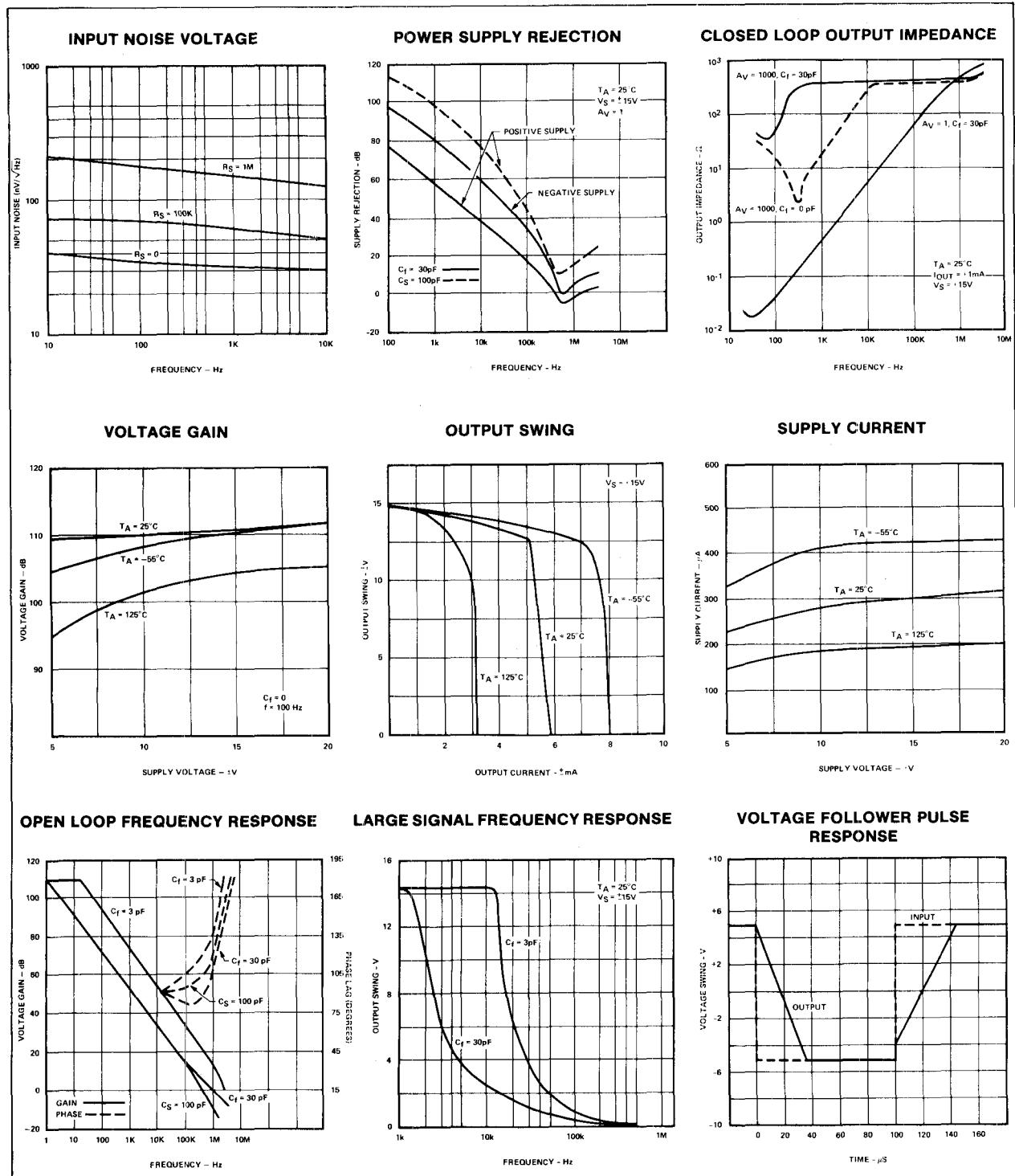
| PARAMETER                                        | TEST CONDITIONS                                                                                                                       | LM108A/LH2108A |     |     | LM208A/LH2208A |     |     | LM308A/LH2308A |     |     | UNIT |
|--------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|----------------|-----|-----|----------------|-----|-----|----------------|-----|-----|------|
|                                                  |                                                                                                                                       | Min            | Typ | Max | Min            | Typ | Max | Min            | Typ | Max |      |
| $A_{VOL}$ Large signal voltage gain <sup>1</sup> | $R_L \geq 10\text{k}\Omega$<br>Over temp.<br>$V_S = 15\text{V}$ , $V_{OUT} = \pm 10\text{V}$ ,<br>$R_L \geq 10\text{k}$<br>Over temp. | 80             | 300 |     | 80             | 300 |     |                |     |     | V/mV |
|                                                  |                                                                                                                                       | 40             |     |     | 40             |     |     |                |     |     | V/mV |
|                                                  |                                                                                                                                       |                |     |     |                |     |     | 80             | 300 |     | V/mV |
|                                                  |                                                                                                                                       |                |     |     |                |     |     | 60             |     |     | V/mV |

## NOTE

1. The maximum junction temperature of the LM1XX is  $150^\circ\text{C}$ , while that of the LM2XX is  $200^\circ\text{C}$ . For operating at elevated temperatures, devices must be derated based on the thermal resistance of the package as given in the package information section.

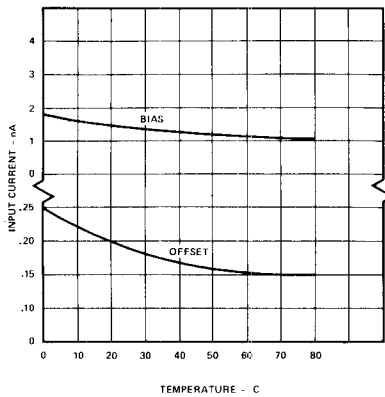
**TYPICAL PERFORMANCE CHARACTERISTICS LM108/208**

TYPICAL PERFORMANCE CHARACTERISTICS LM108/208 (Cont'd)

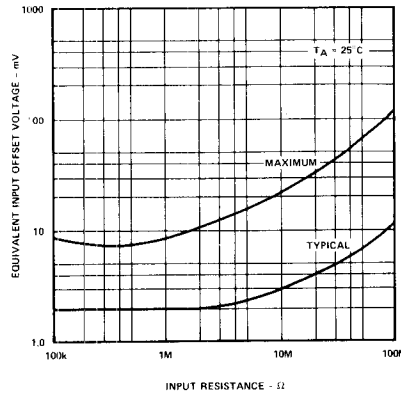


TYPICAL PERFORMANCE CHARACTERISTICS LM308

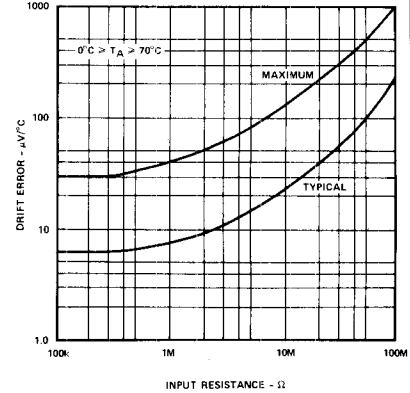
INPUT CURRENTS



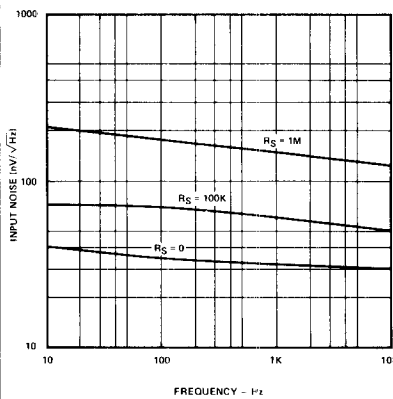
OFFSET ERROR



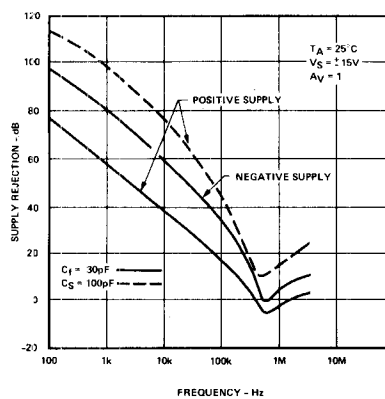
DRIFT ERROR



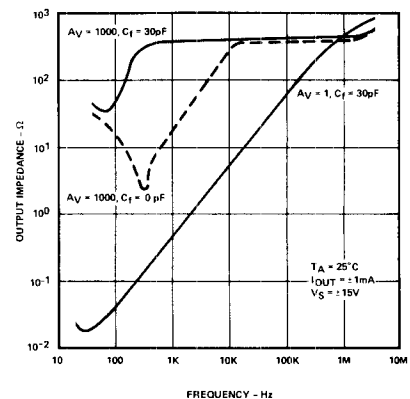
INPUT NOISE VOLTAGE



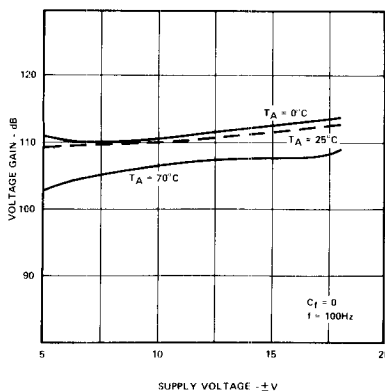
POWER SUPPLY REJECTION



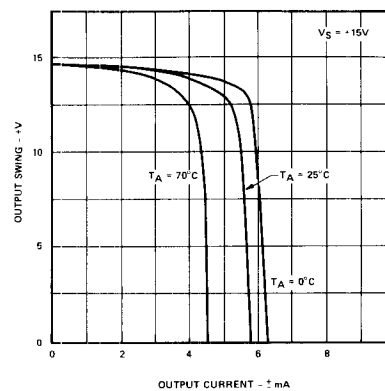
CLOSED LOOP OUTPUT IMPEDANCE



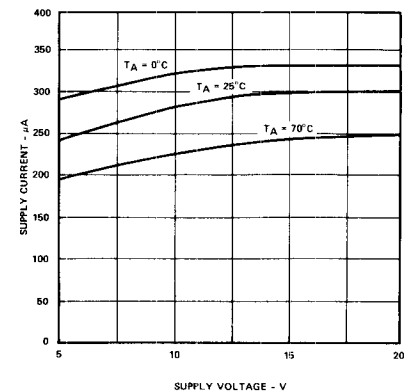
VOLTAGE GAIN



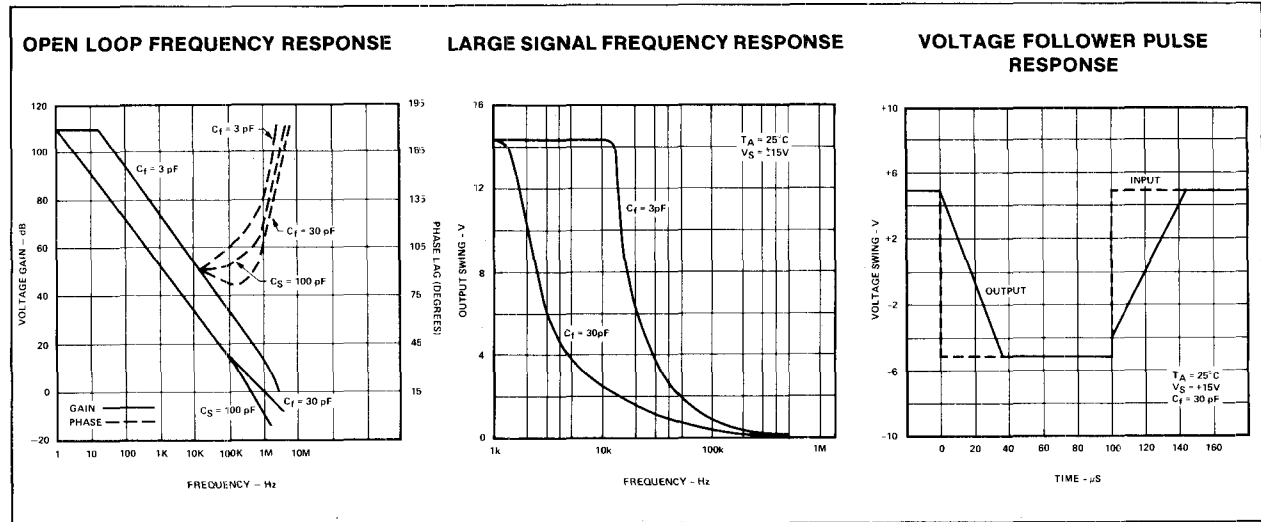
OUTPUT SWING



SUPPLY CURRENT



TYPICAL PERFORMANCE CHARACTERISTICS LM308 (Cont'd)



TEST LOAD CIRCUITS

