

# $\mu$ A108/A • $\mu$ A208/A • $\mu$ A308/A Super Beta Operational Amplifiers

Linear Division Operational Amplifiers

### Description

The  $\mu$ A108 Super Beta Operational Amplifier series is constructed using the Fairchild Planar Epitaxial process. High input impedance, low noise, low input offsets, and low temperature drifts are made possible through use of super beta processing, making the device suitable for applications requiring high accuracy and low drift performance. The  $\mu$ A108 series is specially selected for extremely low offset voltage and drift, and high common mode rejection, giving superior performance in applications where offset nulling is undesirable. Increased slew rate without performance compromise is available through use of feed forward compensation techniques, maximizing performance in high speed sample-and-hold circuits and precision high speed summing amplifiers. The wide supply range and excellent supply voltage rejection assure maximum flexibility in voltage follower, summing, and general feedback applications.

- **Guaranteed Low Input Offset Characteristics**
- **High Input Impedance**
- **Low Offset Current**
- **Low Bias Current**
- **Operation Over Wide Supply Range**

### Absolute Maximum Ratings

#### Storage Temperature Range

Metal Can	-65°C to +175°C
Molded DIP and SO-8	-65°C to +150°C

#### Operating Temperature Range

Extended ( $\mu$ A108AM, $\mu$ A108M)	-55°C to +125°C
Industrial ( $\mu$ A208AV, $\mu$ A108V)	-25°C to +85°C
Commercial ( $\mu$ A308AC, $\mu$ A308C)	0°C to +70°C

#### Lead Temperature

Metal Can (soldering, 60 s)	300°C
Molded DIP and SO-8 (soldering, 10 s)	265°C

#### Internal Power Dissipation<sup>1, 2</sup>

8L-Metal Can	1.00 W
8L-Molded DIP	0.93 W
SO-8	0.81 W

#### Supply Voltage

$\mu$ A108/A, $\mu$ A208/A	$\pm 20$ V
$\mu$ A308/A	$\pm 18$ V

#### Differential Input Current<sup>3</sup>

	$\pm 10$ mA
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#### Input Voltage<sup>4</sup>

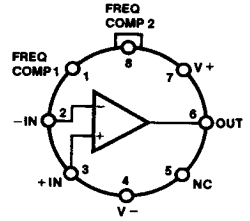
	$\pm 15$ V
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#### Output Short Circuit Duration<sup>5</sup>

	Indefinite
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- Notes**
1.  $T_J$  Max = 150°C for the Molded DIP and SO-8, and 175°C for the Metal Can.
  2. Ratings apply to ambient temperature at 25°C. Above this temperature, derate the 8L-Metal Can at 6.7 mW/°C, the 8L-Molded DIP at 7.5 mW/°C, and the SO-8 at 6.5 mW/°C.
  3. 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 1.0 V is applied between the inputs unless adequate limiting resistance is used.

### Connection Diagram 8-Lead Metal Package (Top View)



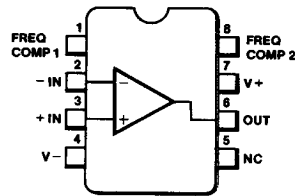
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Lead 4 connected to case.

### Order Information

Device Code	Package Code	Package Description
$\mu$ A108HM	5W	Metal
$\mu$ A108AHM	5W	Metal
$\mu$ A208HV	5W	Metal
$\mu$ A208AHV	5W	Metal
$\mu$ A308HC	5W	Metal
$\mu$ A308AHC	5W	Metal

### Connection Diagram 8-Lead DIP and SO-8 Package (Top View)



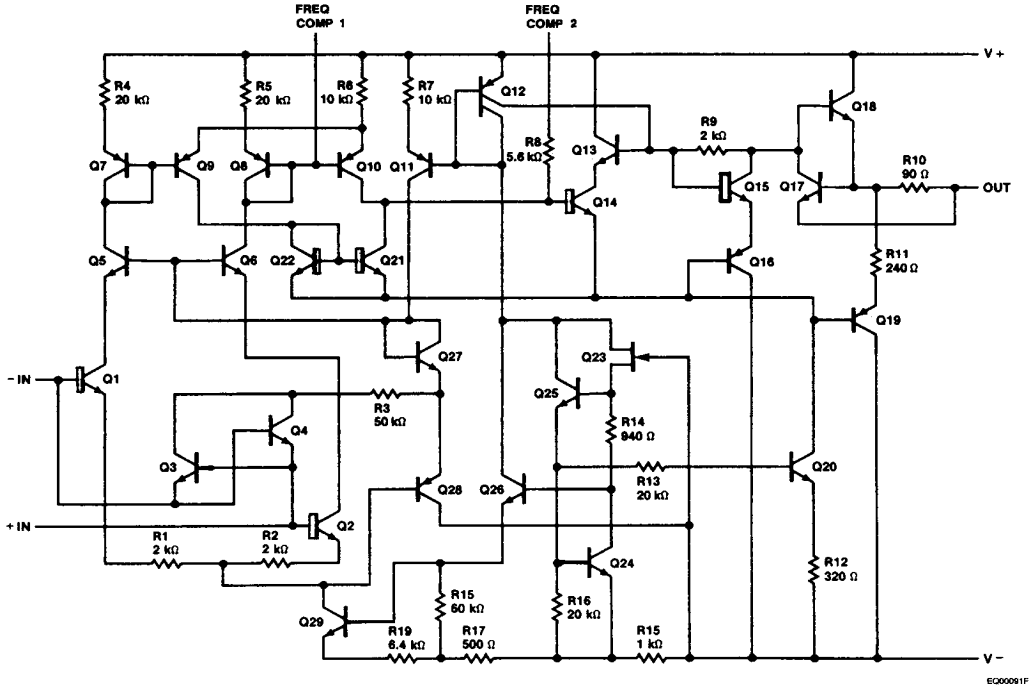
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### Order Information

Device Code	Package Code	Package Description
$\mu$ A308SC	KC	Molded Surface Mount
$\mu$ A308TC	9T	Molded DIP
$\mu$ A308ASC	KC	Molded Surface Mount
$\mu$ A308ATC	9T	Molded DIP

4. For supply voltages less than  $\pm 15$  V, the absolute maximum input voltage is equal to the supply voltage.
5. Short circuit may be to either supply or ground. Rating applies to operation up to the maximum operating temperature range.

Equivalent Circuit



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**μA108/A and μA208/A**

**Electrical Characteristics**  $\pm 5.0 \text{ V} \leq V_{CC} \leq \pm 20 \text{ V}$ ,  $T_A = 25^\circ\text{C}$ , unless otherwise specified.

Symbol	Characteristic	Condition	μA108A μA208A			μA108 μA208			Unit
			Min	Typ	Max	Min	Typ	Max	
$V_{IO}$	Input Offset Voltage			0.3	0.5		0.7	2.0	mV
$I_{IO}$	Input Offset Current			0.05	0.2		0.05	0.2	nA
$I_{IB}$	Input Bias Current			0.8	2.0		0.8	2.0	nA
$Z_I$	Input Impedance		30	70		30	70		MΩ
$I_{CC}$	Supply Current	$V_{CC} = \pm 20 \text{ V}$		.03	0.6		0.3	0.6	mA
$A_{VS}$	Large Signal Voltage Gain	$V_{CC} = \pm 15 \text{ V}$ , $V_O = \pm 10 \text{ V}$ , $R_L \geq 10 \Omega$	80	300		50	300		V/mV

The following specifications apply over the range of  $-55^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$  for the μA108/A, and  $-25^\circ\text{C} \leq T_A \leq +85^\circ\text{C}$  for the μA208/A, unless otherwise specified.

$V_{IO}$	Input Offset Voltage				1.0			3.0	mV
$\Delta V_{IO}/\Delta T$	Input Offset Voltage Temperature Sensitivity			1.0	5.0		3.0	15	μV/°C
$I_{IO}$	Input Offset Current				0.4			0.4	nA
$\Delta I_{IO}/\Delta T$	Input Offset Current Temperature Sensitivity			0.5	2.5		0.5	2.5	pA/°C
$I_{IB}$	Input Bias Current			0.8	3.0			3.0	nA
$I_{CC}$	Supply Current	$V_{CC} = \pm 20 \text{ V}$ , $T_A = 125^\circ\text{C}$		0.15	0.4		0.15	0.4	mA
CMR	Common Mode Rejection		96	110		85	100		dB
$V_{IR}$	Input Voltage Range	$V_{CC} = \pm 15 \text{ V}$	±13.5			±13.5			V
PSRR	Power Supply Rejection Ratio	$V_{CC} = \pm 5.0 \text{ V}$ to $\pm 20 \text{ V}$	96	110		80	96		dB
$A_{VS}$	Large Signal Voltage Gain	$V_{CC} = \pm 15 \text{ V}$ , $V_O = \pm 10 \text{ V}$ , $R_L \geq 10 \Omega$	40			25			V/mV
$V_{OP}$	Output Voltage Swing	$V_{CC} = \pm 15 \text{ V}$ , $R_L = 10 \text{ k}\Omega$	±13	±14		±13	±14		V

**μA308/A**

**Electrical Characteristics**  $T_A = 25^\circ\text{C}$ ,  $\pm 5.0 \text{ V} \leq V_{CC} \leq \pm 15 \text{ V}$ , unless otherwise specified.

Symbol	Characteristic	Condition	μA308A			μA308			Unit
			Min	Typ	Max	Min	Typ	Max	
$V_{IO}$	Input Offset Voltage			0.3	0.5		2.0	7.5	mV
$I_{IO}$	Input Offset Current			0.2	1.0		0.2	1.0	nA
$I_{IB}$	Input Bias Current			1.5	7.0		1.5	7.0	nA
$Z_I$	Input Impedance		10	40		10	40		MΩ

μA308/A (Cont.)

Electrical Characteristics  $T_A = 25^\circ\text{C}$ ,  $\pm 5.0\text{ V} \leq V_{CC} \leq \pm 15\text{ V}$ , unless otherwise specified.

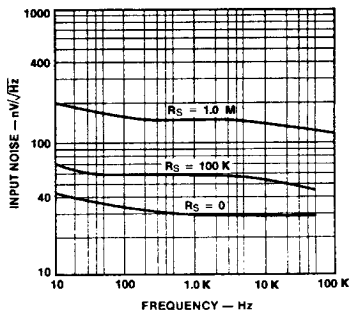
Symbol	Characteristic	Condition	μA308A			μA308			Unit
			Min	Typ	Max	Min	Typ	Max	
$I_{CC}$	Supply Current	$V_{CC} = \pm 15\text{ V}$		0.3	0.8		0.3	0.8	mA
$A_{VS}$	Large Signal Voltage Gain	$V_{CC} = \pm 15\text{ V}$ , $V_O = \pm 10\text{ V}$ , $R_L \geq 10\ \Omega$	80	300		25	300		V/mV

The following specifications apply over the range of  $0^\circ\text{C} \leq T_A \leq +70^\circ\text{C}$

$V_{IO}$	Input Offset Voltage				0.73			10	mV
$\Delta V_{IO}/\Delta T$	Input Offset Voltage Temperature Sensitivity			1.0	5.0		6.0	30	$\mu\text{V}/^\circ\text{C}$
$I_{IO}$	Input Offset Current				1.5			1.5	nA
$\Delta I_{IO}/\Delta T$	Input Offset Current Temperature Sensitivity			2.0	10		2.0	10	$\text{pA}/^\circ\text{C}$
$I_{IB}$	Input Bias Current				10			10	nA
CMR	Common Mode Rejection		96	110		80	100		dB
$V_{IR}$	Input Voltage Range	$V_{CC} = \pm 15\text{ V}$	$\pm 13.5$			$\pm 13.5$			V
PSRR	Power Supply Rejection Ratio	$V_{CC} = \pm 5.0\text{ V}$ to $\pm 18\text{ V}$	96	110		80	96		dB
$A_{VS}$	Large Signal Voltage Gain	$V_{CC} = \pm 15\text{ V}$ , $V_O = \pm 10\text{ V}$ , $R_L \geq 10\text{ k}\Omega$	60			15			V/mV
$V_{OP}$	Output Voltage Swing	$V_{CC} = \pm 15\text{ V}$ , $R_L = 10\text{ k}\Omega$	$\pm 13$	$\pm 14$		$\pm 13$	$\pm 14$		V

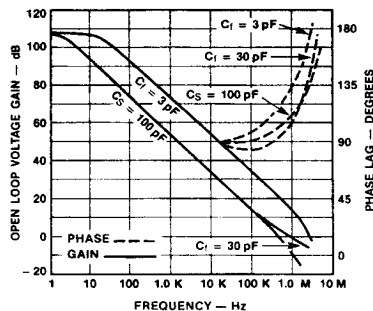
Typical Performance Curves for μA108 Series

Input Noise Voltage vs Frequency



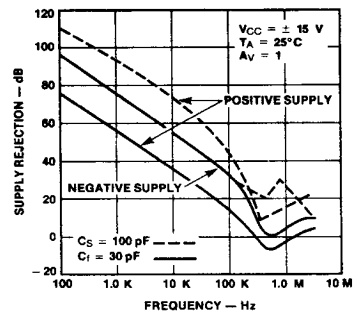
PC03771F

Open Loop Frequency Response



PC03791F

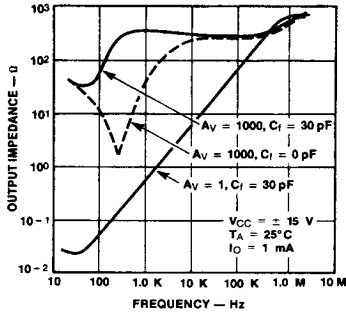
Supply Rejection vs Frequency



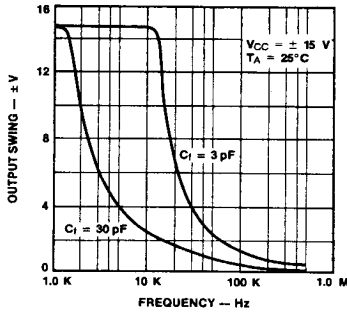
PC03781F

Typical Performance Curves for  $\mu$ A108 Series (Cont.)

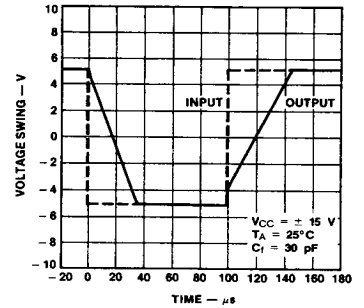
Closed Loop Output Impedance vs Frequency



Large Signal Frequency Response

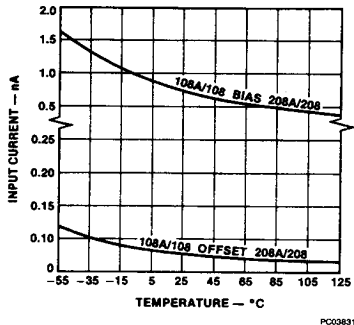


Voltage Follower Pulse Response

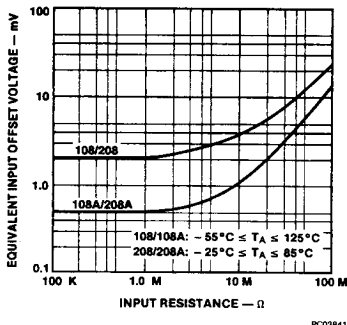


Typical Performance Curves for  $\mu$ A108/A, and  $\mu$ A208/A (Unless otherwise specified)

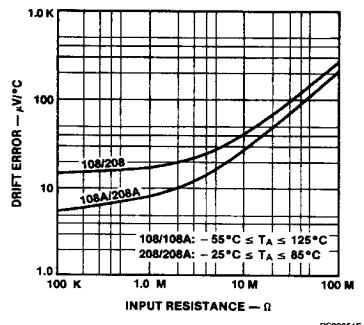
Input Currents vs Temperature



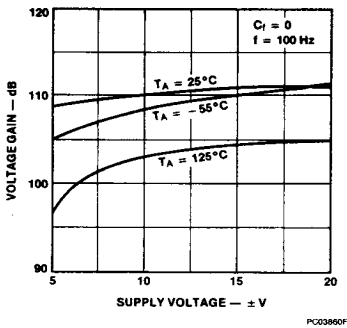
Maximum Offset Error



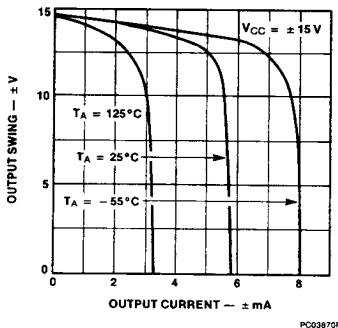
Maximum Drift Error



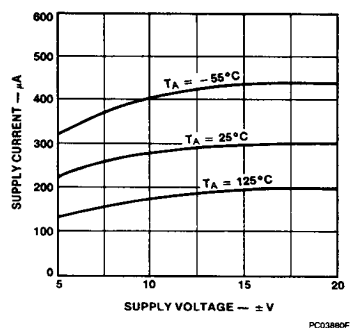
Voltage Gain vs Supply Voltage ( $\mu$ A108)



Output Swing vs Output Current ( $\mu$ A108)

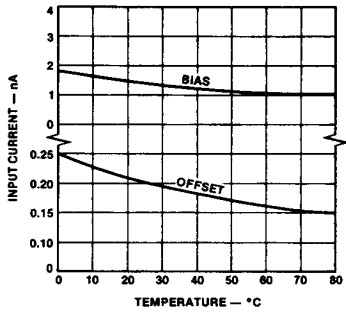


Supply Current vs Supply Voltage ( $\mu$ A108)



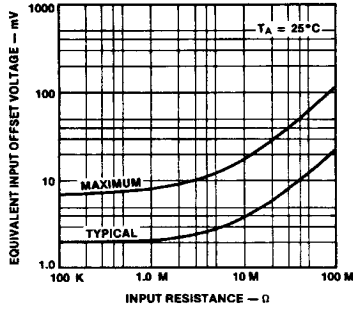
Typical Performance Curves for  $\mu A308/A$  (Unless otherwise specified)

Input Current vs Temperature



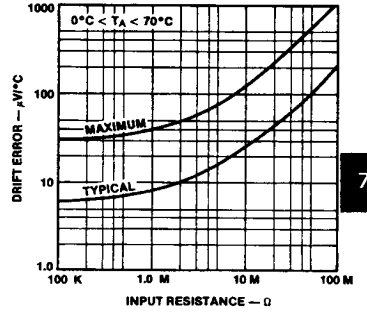
PC03900F

Maximum Offset Error ( $\mu A308$ )



PC03901F

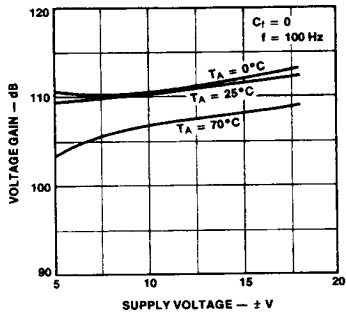
Maximum Drift Error ( $\mu A308$ )



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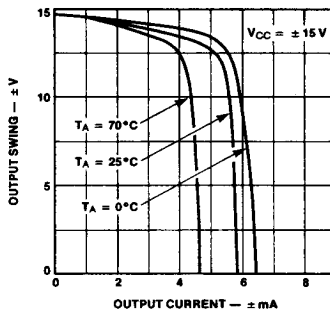
PC03911F

Voltage Gain vs Supply Voltage



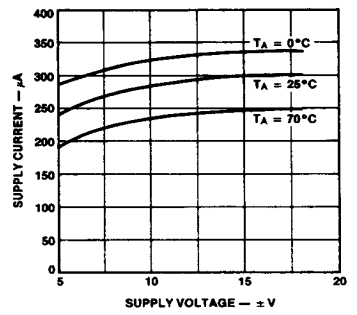
PC03921F

Output Swing vs Output Current



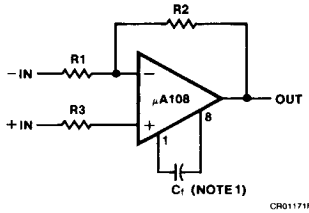
PC03930F

Supply Current vs Supply Voltage

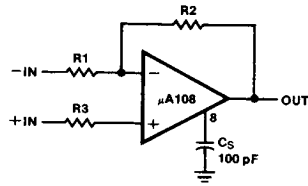


PC03940F

Standard Compensation Circuits



CR01171F



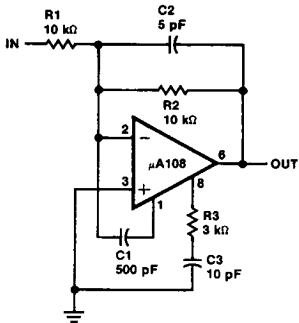
CR01181F

Note

1.  $C_F \geq 30 \left( \frac{1}{1 + \frac{R_2}{R_1}} \right)$

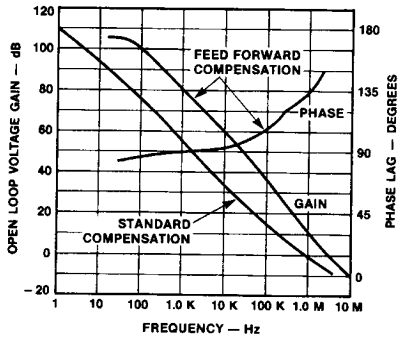
**Feed Forward Compensation  
Higher Slew Rate and  
Wider Bandwidth**

**Standard Feed Forward**



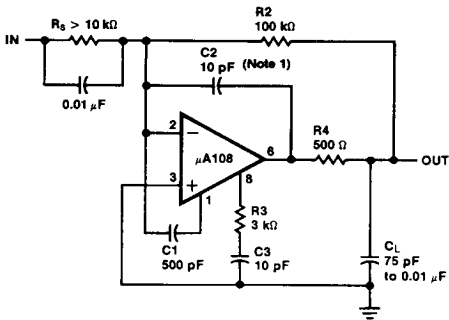
CR01191F

**Open Loop Frequency Response**



PC03951F

**Feed Forward Compensation for Decoupling Load Capacitance**



CR01201F

**Note**

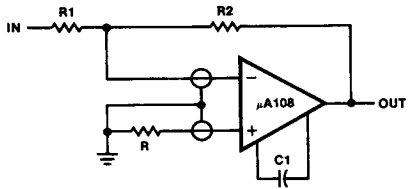
$$1. C_2 > \frac{5 \times 10^5}{R_2} \text{ pF}$$

**Guarding**

Extra care must be taken in the assembly of printed circuit boards to take full advantage of the low input currents of the  $\mu$ A108 amplifier. Boards must be thoroughly cleaned with TCE or alcohol and blown dry with compressed air. After cleaning, the boards should be coated with epoxy or silicone rubber to prevent contamination. Even with properly cleaned and coated boards, leakage currents may cause trouble at 125°C, particularly since the input leads are adjacent to leads that are at supply potentials. This leakage can be significantly reduced by using guarding to lower the voltage difference between the inputs and adjacent metal runs. Input guarding of the 8-lead TO-99 package is accomplished by using a 10-lead circle, with the leads of the device formed so that the holes adjacent to the inputs are empty when it is inserted in the board. The guard, which is a conductive ring surrounding the inputs, is connected to a low impedance point that is at approximately the same voltage as the inputs. Leakage currents from high voltage leads are then absorbed by the guard.

The lead configuration of the dual-in-line package is designed to facilitate guarding, since the leads adjacent to the inputs are not used (this is different from the standard  $\mu$ A741 and  $\mu$ A101A lead configuration).

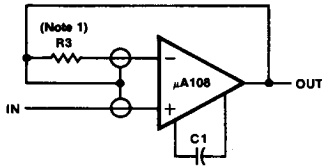
**Inverting Amplifier**



CR01211F

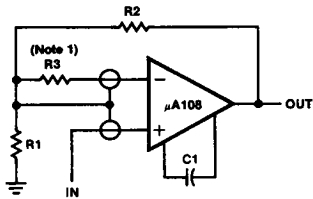
$R = R_1 || R_2$  (must be low impedance)

**Follower**



CR01221F

**Non-Inverting Amplifier**

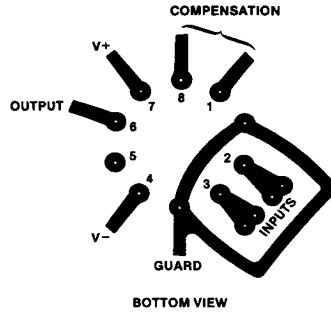


CR01231F

**Note**

1. Use to compensate for large source resistances.

**Board Layout for Input Guarding With Metal Package**



CR01240F