

T-79-06-10



MOTOROLA

**LM108, LM108A
LM208, LM208A
LM308, LM308A**

PRECISION OPERATIONAL AMPLIFIERS

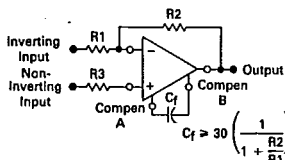
The LM108/LM208/LM308 Series operational amplifiers provide high input impedance, low input offsets and temperature drifts, and low noise. These characteristics are made possible by use of a special Super Beta processing technology. This series of amplifiers is particularly useful for applications where high-accuracy and low-drift performance are essential. In addition high-speed performance may be improved by employing feed-forward compensation techniques to maximize slew rate without compromising other performance criteria.

The LM108A/LM208A/LM308A Series offers extremely low input offset voltage and drift specifications allowing usage in even the most critical applications without external offset nulling.

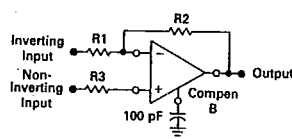
- Operation From a Wide Range of Power Supply Voltages
- Low Input Bias and Offset Currents
- Low Input Offset Voltage and Guaranteed Offset Voltage Drift Performance
- High Input Impedance

FREQUENCY COMPENSATION

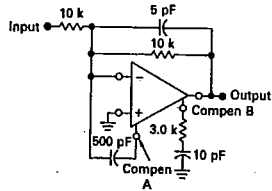
Standard Compensation



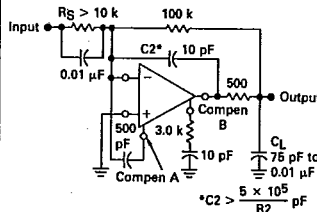
Modified Compensation



Standard Feedforward Compensation



Feedforward Compensations for Decoupling Load Capacitance



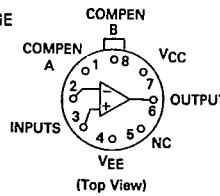
ORDERING INFORMATION

Device	Temperature Range	Package
LM108AH, H	-55 to +125°C	Metal Can
LM108AJ, J, AJ-8, J-8	-55 to +125°C	Ceramic DIP
LM208AH, H	-25 to +85°C	Metal Can
LM208AJ, J, AJ-8, J-8	-25 to +85°C	Ceramic DIP
LM208AN, N	-25 to +85°C	Plastic DIP
LM208AD, D	-25 to +85°C	SO-8
LM308AH, H	0 to +70°C	Metal Can
LM308AJ, J, AJ-8, J-8	0 to +70°C	Ceramic DIP
LM308AN, N	0 to +70°C	Plastic DIP
LM308AD, D	0 to +70°C	SO-8

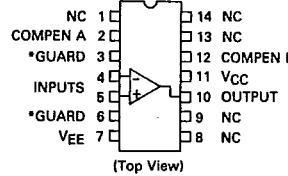
SUPER GAIN OPERATIONAL AMPLIFIERS

SILICON MONOLITHIC INTEGRATED CIRCUIT

H SUFFIX
METAL PACKAGE
CASE 601-04



J SUFFIX
CERAMIC PACKAGE
CASE 632-08



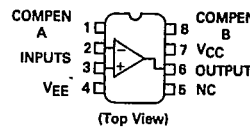
N SUFFIX
PLASTIC PACKAGE
CASE 626-05
(LM208, LM208A)
(LM308, LM308A Only)



J-8 SUFFIX
CERAMIC PACKAGE
CASE 693-02



D SUFFIX
PLASTIC PACKAGE
CASE 751-02
SO-8



*Unused pin (no internal connection) to allow for input anti-leakage guard ring on printed circuit board layout.

LM108, LM108A, LM208, LM208A, LM308, LM308A

T-79-06-16

MAXIMUM RATINGS ($T_A = +25^\circ\text{C}$ unless otherwise noted.)

Rating	Symbol	Value			Unit
		LM108, LM108A	LM208, LM208A	LM308, LM308A	
Power Supply Voltage	V_{CC}, V_{EE}	± 20	± 20	± 18	Vdc
Input Voltage (See Note 1)	V_I	± 15			Volts
Input Differential Current (See Note 2)	I_{ID}	± 10			mA
Output Short-Circuit Duration	t_s	Indefinite			
Operating Ambient Temperature Range	T_A	-55 to +125	-25 to +85	0 to +70	$^\circ\text{C}$
Storage Temperature Range	T_{stg}	-65 to +150			$^\circ\text{C}$
Junction Temperature Metal, Ceramic Package Plastic Package	T_J	± 175			$^\circ\text{C}$
		± 150			

Note 1. For supply voltages less than ± 15 V, the maximum input voltage is equal to the supply voltage.

Note 2. The inputs are shunted with back-to-back diodes for over-voltage protection. Therefore, excessive current will flow if a differential input voltage in excess of 1.0 V is applied between the inputs unless some limiting resistance is used.

ELECTRICAL CHARACTERISTICS (Unless otherwise noted these specifications apply for supply voltages of $+5.0\text{ V} \leq V_{CC} \leq +20\text{ V}$ and $-5.0\text{ V} \geq V_{EE} \geq -20\text{ V}$, $T_A = +25^\circ\text{C}$.)

Characteristic	Symbol	LM108A LM208A			LM108 LM208			Unit
		Min	Typ	Max	Min	Typ	Max	
Input Offset Voltage	V_{IO}	—	0.3	0.5	—	0.7	2.0	mV
Input Offset Current	I_{IO}	—	0.05	0.2	—	0.005	0.2	nA
Input Bias Current	I_{IB}	—	0.8	2.0	—	0.8	2.0	nA
Input Resistance	r_i	30	70	—	30	70	—	Megohms
Power Supply Currents $V_{CC} = +20\text{ V}, V_{EE} = -20\text{ V}$	I_{CC}, I_{EE}	—	± 0.3	± 0.6	—	± 0.3	± 0.6	mA
Large Signal Voltage Gain $V_{CC} = V_{EE} = +15\text{ V}, V_O = \pm 10\text{ V}, R_L \geq 10\text{ k}\Omega$	A_{VOL}	80	300	—	50	300	—	V/mV

The following specifications apply over the operating temperature range.

Input Offset Voltage	V_{IO}	—	—	1.0	—	—	3.0	mV
Input Offset Current	I_{IO}	—	—	0.4	—	—	0.4	nA
Average Temperature Coefficient of Input Offset Voltage $T_A(\text{min}) \leq T_A \leq T_A(\text{max})$	$\Delta V_{IO}/\Delta T$	—	1.0	5.0	—	3.0	15	$\mu\text{V}/^\circ\text{C}$
Average Temperature Coefficient of Input Offset Current	$\Delta I_{IO}/\Delta T$	—	0.5	2.5	—	0.5	2.5	$\text{pA}/^\circ\text{C}$
Input Bias Current	I_{IB}	—	—	3.0	—	—	3.0	nA
Large Signal Voltage Gain $V_{CC} = V_{EE} = +15\text{ V}, V_O = \pm 10\text{ V}, R_L = 10\text{ k}\Omega$	A_{VOL}	40	—	—	25	—	—	V/mV
Input Voltage Range $V_{CC} = V_{EE} = +15\text{ V}$	V_{IR}	± 13.5	—	—	± 13.5	—	—	V
Common-Mode Rejection Ratio	CMRR	96	110	—	85	100	—	dB
Power Supply Voltage Rejection Ratio	PSRR	96	100	—	80	96	—	dB
Output Voltage Range $V_{CC} = V_{EE} = +15\text{ V}, R_L = 10\text{ k}\Omega$	V_{OR}	± 13	± 14	—	± 13	± 14	—	V
Supply Current ($T_A = T_A(\text{max})$)	I_{CC}, I_{EE}	—	± 0.15	± 0.4	—	± 0.15	± 0.4	mA

LM108, LM108A, LM208, LM208A, LM308, LM308A

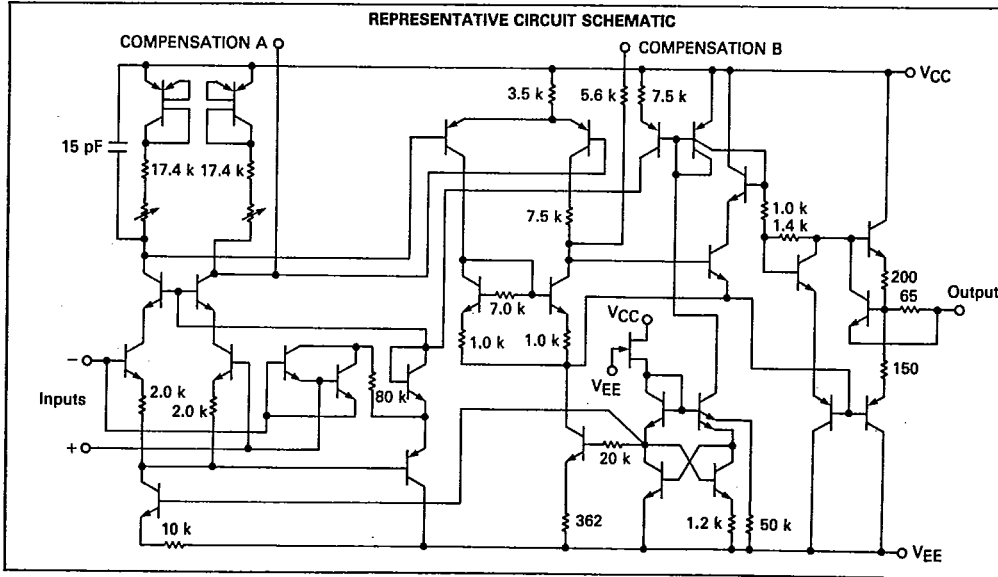
T-79-06-10

ELECTRICAL CHARACTERISTICS (Unless otherwise noted these specifications apply for supply voltages of $+5.0\text{ V} \leq V_{CC} \leq +15\text{ V}$ and $-5.0\text{ V} \geq V_{EE} \geq -15\text{ V}$, $T_A = +25^\circ\text{C}$.)

Characteristic	Symbol	LM308A			LM308			Unit
		Min	Typ	Max	Min	Typ	Max	
Input Offset Voltage	V_{IO}	—	0.3	0.5	—	2.0	7.5	mV
Input Offset Current	I_{IO}	—	0.2	1.0	—	0.2	1.0	nA
Input Bias Current	I_{IB}	—	1.5	7.0	—	1.5	7.0	nA
Input Resistance	r_i	10	40	—	10	40	—	Megohms
Power Supply Currents $V_{CC} = +15\text{ V}$, $V_{EE} = -15\text{ V}$	I_{CC}, I_{EE}	—	± 0.3	± 0.8	—	± 0.3	± 0.8	mA
Large Signal Voltage Gain $V_{CC} = +15\text{ V}$, $V_{EE} = -15\text{ V}$, $V_O = \pm 10\text{ V}$, $R_L \geq 10\text{ k}\Omega$	A_{VOL}	80	300	—	25	300	—	V/mV

The following specifications apply over the operating temperature range.

Input Offset Voltage	V_{IO}	—	—	0.73	—	—	10	mV
Input Offset Current	I_{IO}	—	—	1.5	—	—	1.5	nA
Average Temperature Coefficient of Input Offset Voltage $T_A(\text{min}) \leq T_A \leq T_A(\text{max})$	$\Delta V_{IO}/\Delta T$	—	1.0	5.0	—	6.0	30	$\mu\text{V}/^\circ\text{C}$
Average Temperature Coefficient of Input Offset Current	$\Delta I_{IO}/\Delta T$	—	2.0	10	—	2.0	10	$\text{pA}/^\circ\text{C}$
Input Bias Current	I_{IB}	—	—	10	—	—	10	nA
Large Signal Voltage Gain $V_{CC} = +15\text{ V}$, $V_{EE} = -15\text{ V}$, $V_O = \pm 10\text{ V}$, $R_L \geq 10\text{ k}\Omega$	A_{VOL}	60	—	—	15	—	—	V/mV
Input Voltage Range $V_{CC} = +15\text{ V}$, $V_{EE} = -15\text{ V}$	V_{IR}	± 14	—	—	± 14	—	—	V
Common-Mode Rejection Ratio $R_S \leq 50\text{ k}\Omega$	CMRR	96	110	—	80	100	—	dB
Supply Voltage Rejection Ratio $R_S \leq 50\text{ k}\Omega$	PSRR	96	110	—	80	96	—	dB
Output Voltage Range $V_{CC} = +15\text{ V}$, $V_{EE} = -15\text{ V}$, $R_L = 10\text{ k}\Omega$	V_{OR}	± 13	± 14	—	± 13	± 14	—	V



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T-79-06-10

TYPICAL CHARACTERISTICS

2

FIGURE 1 - INPUT BIAS AND INPUT OFFSET CURRENTS

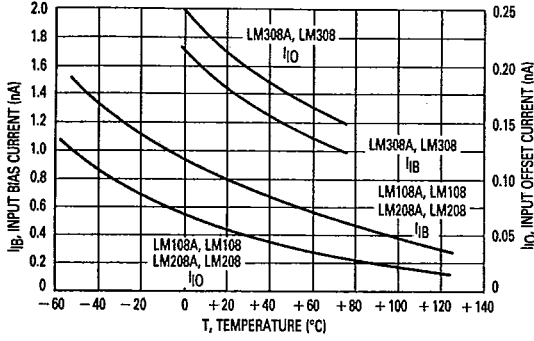


FIGURE 2 - MAXIMUM EQUIVALENT INPUT OFFSET VOLTAGE ERROR versus INPUT RESISTANCE

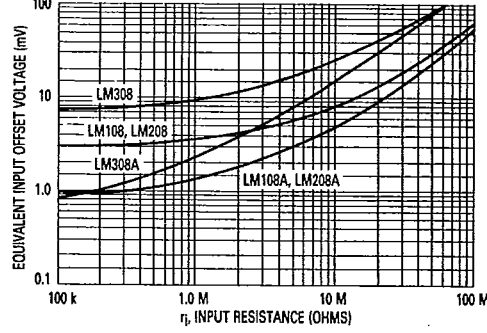


FIGURE 3 - VOLTAGE GAIN versus SUPPLY VOLTAGES

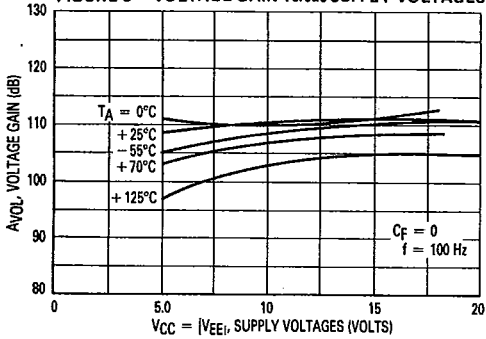


FIGURE 4 - POWER SUPPLY CURRENTS versus POWER SUPPLY VOLTAGE

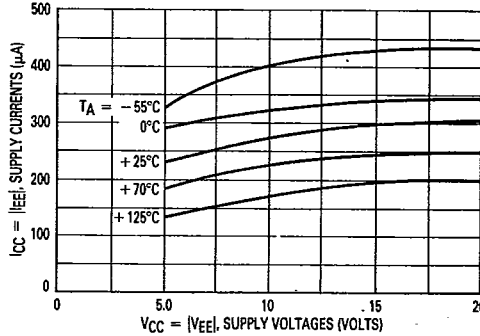


FIGURE 5 - OPEN-LOOP FREQUENCY RESPONSE

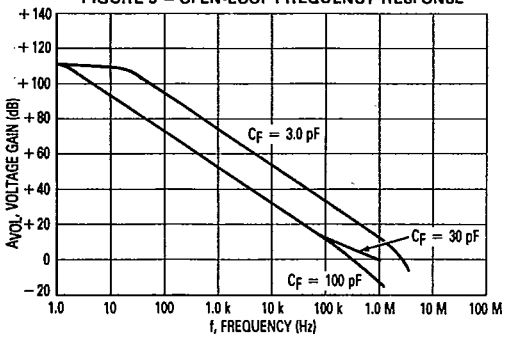
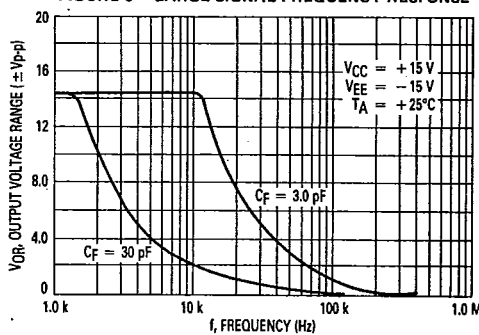


FIGURE 6 - LARGE-SIGNAL FREQUENCY RESPONSE

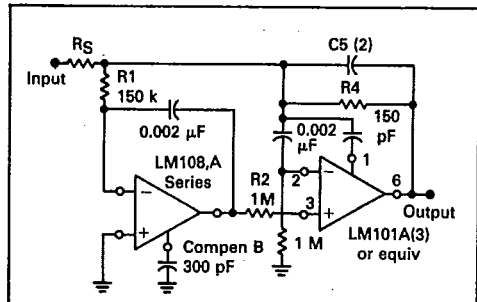


LM108, LM108A, LM208, LM208A, LM308, LM308A

T-79-06-10

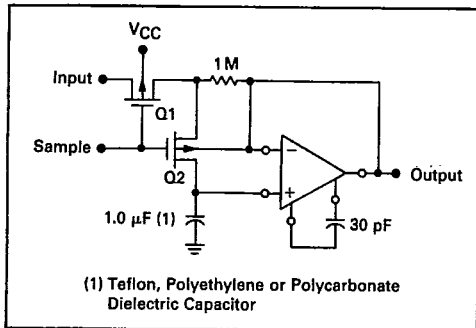
SUGGESTED DESIGN APPLICATIONS

FIGURE 7 — FAST (1) SUMMING AMPLIFIER WITH LOW INPUT CURRENT



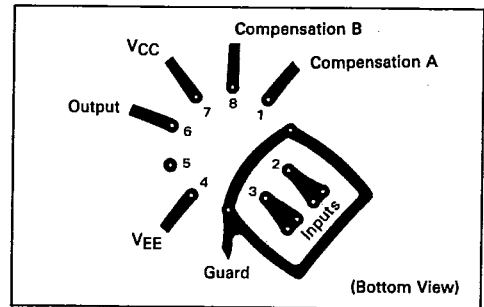
- (1) Power Bandwidth: 260 kHz
- Small Signal Bandwidth: 3.5 MHz
- Slow Rate: 10 V/μs
- (2) $C5 = \frac{6 \times 10^{-8}}{R1}$
- (3) In addition to increasing speed, the LM101A raises high and low frequency gain, increases output drive capability and eliminates thermal feedback.

FIGURE 8 — SAMPLE AND HOLD



(1) Teflon, Polyethylene or Polycarbonate Dielectric Capacitor

FIGURE 9 — SUGGESTED PRINTED CIRCUIT BOARD LAYOUT for INPUT GUARDING USING METAL PACKAGED DEVICE



INPUT GUARDING

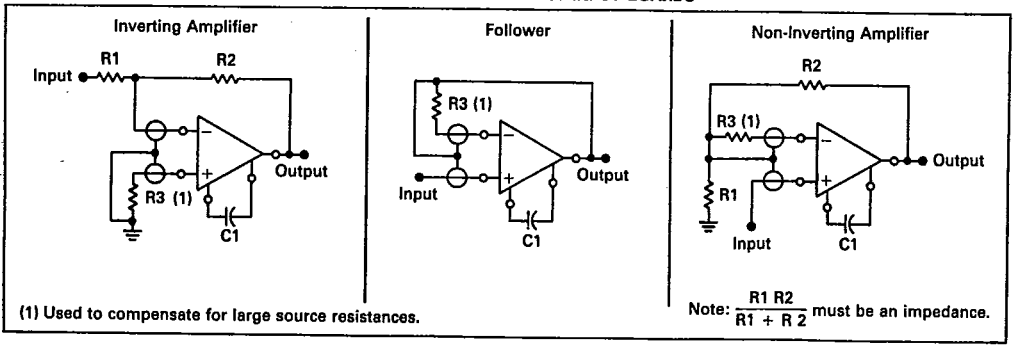
Special care must be taken in the assembly of printed circuit boards to take full advantage of the low input currents of the LM108,A amplifier series. Boards must be thoroughly cleaned with alcohol and blown dry with compressed air. After cleaning, the boards should be coated with epoxy or silicone rubber to prevent contamination.

Even with properly cleaned and coated boards, leakage currents may cause trouble at +125°C, particularly since the input pins are adjacent to pins 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 type package is accomplished by using a 10-lead pin circle, with the leads of the device formed so that the holes adjacent to the inputs are empty when it is inserted in the boards. 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 pins are then absorbed by the guard.

The pin configuration of the dual in-line package is designed to facilitate guarding, since the pins adjacent to the inputs are not used (this is different from the standard MC1741 and LM101A pin configuration).

FIGURE 10 — CONNECTION OF INPUT GUARDS



(1) Used to compensate for large source resistances.