

LM108AJAN Operational Amplifiers

Check for Samples: [LM108AJAN](#)

FEATURES

- Maximum Input Bias Current of 3.0 nA over Temperature
- Offset Current less than 400 pA over Temperature
- Supply Current of only 300 μ A, even in Saturation
- Ensured Drift Characteristics

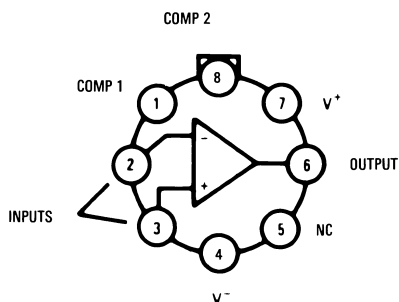
DESCRIPTION

The LM108 is a precision operational amplifier having specifications a factor of ten better than FET amplifiers over a -55°C to $+125^{\circ}\text{C}$ temperature range.

The devices operate with supply voltages from $\pm 2\text{V}$ to $\pm 20\text{V}$ and have sufficient supply rejection to use unregulated supplies. Although the circuit is interchangeable with, and uses the same compensation as the LM101A, an alternate compensation scheme can be used to make it particularly insensitive to power supply noise and to make supply bypass capacitors unnecessary.

The low current error of the LM108 makes possible many designs that are not practical with conventional amplifiers. In fact, it operates from $10\text{ M}\Omega$ source resistances, introducing less error than devices such as the 709 with $10\text{ k}\Omega$ sources. Integrators with drifts less than $500\text{ }\mu\text{V}/\text{sec}$ and analog time delays in excess of one hour can be made using capacitors no larger than $1\text{ }\mu\text{F}$.

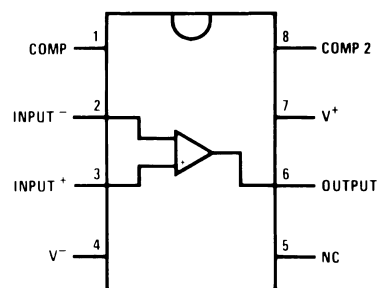
Connection Diagrams



*Package is connected to Pin 4 (V^-)

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

**Figure 1. Metal Can Package - TO-99
Package Number LMC**



**Figure 2. Dual-In-Line Package (Top View)
CDIP - Package Number NAB**



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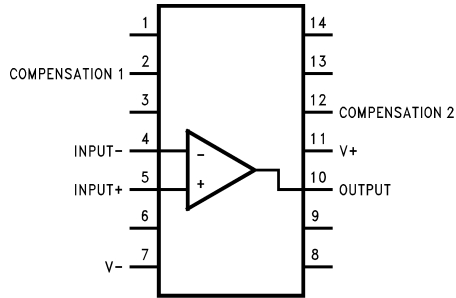


Figure 3. CDIP - Top View Package Number J

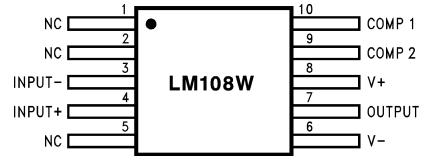
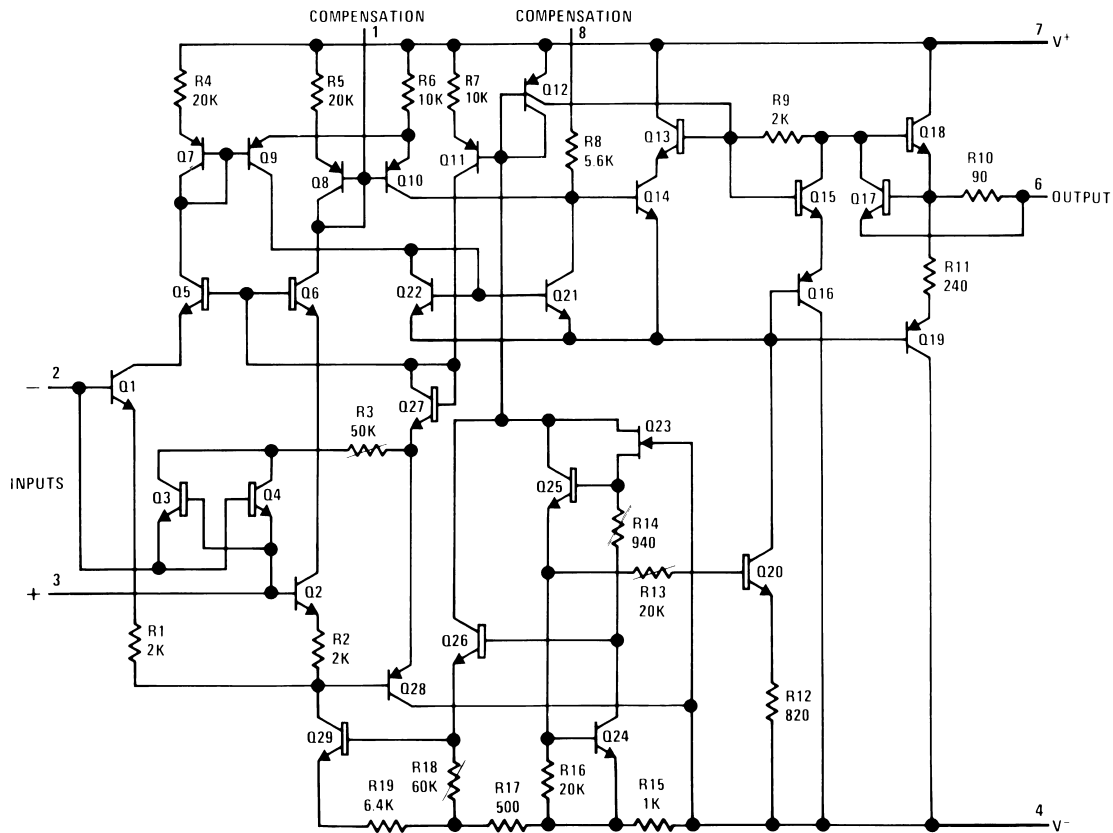
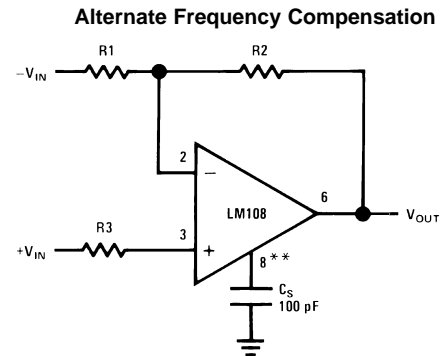
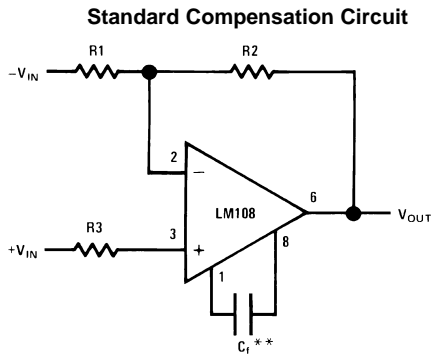


Figure 4. CLGA Top View Package Number NAC, NAD

Schematic Diagram



Compensation Circuits



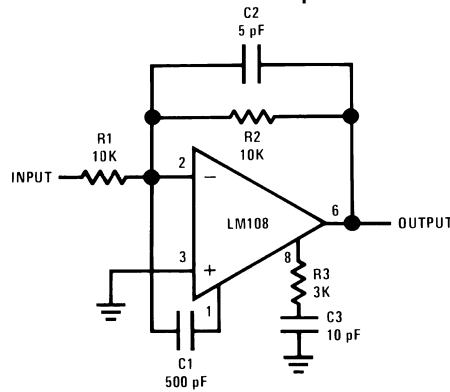
$$C_f \geq \frac{R1 C_o}{R1 + R2}$$

$$C_o = 30 \text{ pF}$$

**Bandwidth and slew rate are proportional to $1/C_f$

**Bandwidth and slew rate are proportional to $1/C_s$
Improves rejection of power supply noise by a factor of ten.

Feedforward Compensation



These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

Absolute Maximum Ratings⁽¹⁾

| | | | |
|---|---------------------|---|--------------------|
| Supply Voltage | | ±22V | |
| Power Dissipation ⁽²⁾ | TO-99 Metal Can 8LD | 330mW @ +125°C | |
| | CDIP 14LD | 400mW @ +125°C | |
| | CDIP 8LD | 400mW @ +125°C | |
| | CLGA 10LD | 330mW @ +125°C | |
| | Ceramic SOIC 10LD | 330mW @ +125°C | |
| Differential Input Current ⁽³⁾ | | ±10 mA | |
| Differential Input Voltage ⁽⁴⁾ | | ±30V | |
| Input Voltage ⁽⁵⁾ | | ±20V | |
| Output Short-Circuit Duration | | Continuous | |
| Operating Temperature Range | | -55°C ≤ T _A ≤ +125°C | |
| Storage Temperature Range | | -65°C ≤ T _A ≤ +150°C | |
| Thermal Resistance | θ _{JA} | TO-99 Metal Can 8LD Still Air 500LF / Min Air Flow | 150°C/W 86°C/W |
| | | CDIP 14LD Still Air 500LF / Min Air Flow | 94°C/W 55°C/W |
| | | CDIP 8LD Still Air 500LF / Min Air Flow | 120°C/W 68°C/W |
| | | CPACK 10LD Still Air 500LF / Min Air Flow | 225°C/W 142°C/W |
| | | Ceramic SOIC 10LD Still Air 500LF / Min Air Flow | 225°C/W 142°C/W |
| | θ _{JC} | TO-99 Metal Can 8LD | 38°C/W |
| | | CDIP 14LD | 13°C/W |
| | | CDIP 8LD | 17°C/W |
| | | CLGA 10LD | 21°C/W |
| | | Ceramic SOIC 10LD | 21°C/W |
| Package Weight (typical) | TO-99 Metal Can 8LD | 990mg | |
| | CDIP 14LD | 2,180mg | |
| | CDIP 8LD | 1,090mg | |
| | CLGA 10LD | 225mg | |
| | Ceramic SOIC 10LD | 210mg | |
| Maximum Junction Temperature | | 175°C | |
| Lead Temperature (Soldering, 10 sec) | | 300°C | |
| ESD Tolerance ⁽⁶⁾ | | 2000V | |

- (1) Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is functional, but do not ensure specific performance limits. For ensured specifications and test conditions, see the Electrical Characteristics. The specified specifications apply only for the test conditions listed. Some performance characteristics may degrade when the device is not operated under the listed test conditions.
- (2) The maximum power dissipation must be derated at elevated temperatures and is dictated by T_{Jmax} (maximum junction temperature), θ_{JA} (package junction to ambient thermal resistance), and T_A (ambient temperature). The maximum allowable power dissipation at any temperature is P_{Dmax} = (T_{Jmax} - T_A) / θ_{JA} or the number given in the Absolute Maximum Ratings, whichever is lower.
- (3) 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 1V is applied between the inputs unless some limiting resistance is used.
- (4) This rating is ±1.0V unless resistances of 2KΩ or greater are inserted in series with the inputs to limit current in the input shunt diodes to the maximum allowable value.
- (5) For supply voltages less than ±20V, the absolute maximum input voltage is equal to the supply voltage.
- (6) Human body model, 1.5 kΩ in series with 100 pF.

Table 1. Quality Conformance Inspection Mil-Std-883, Method 5005 - Group A

| Subgroup | Description | Temp (°C) |
|----------|---------------------|-----------|
| 1 | Static tests at | +25°C |
| 2 | Static tests at | +125°C |
| 3 | Static tests at | -55°C |
| 4 | Dynamic tests at | +25°C |
| 5 | Dynamic tests at | +125°C |
| 6 | Dynamic tests at | -55°C |
| 7 | Functional tests at | +25°C |
| 8A | Functional tests at | +125°C |
| 8B | Functional tests at | -55°C |
| 9 | Switching tests at | +25°C |
| 10 | Switching tests at | +125°C |
| 11 | Switching tests at | -55°C |

LM108A Electrical Characteristics DC Parameters

The following conditions apply to all the following parameters, unless otherwise specified.

DC: $+V_{CC} = +20V$, $-V_{CC} = -20V$, $V_{CM} = 0V$, $R_S = 50\Omega$

| Symbol | Parameter | Conditions | Notes | Min | Max | Units | Sub-groups |
|-----------------------------|--|--|--------------------|------|-----|------------------|------------|
| V_{IO} | Input Offset Voltage | $+V_{CC} = 35V$, $-V_{CC} = -5V$, $V_{CM} = -15V$ | | -0.5 | 0.5 | mV | 1 |
| | | | | -1 | 1 | mV | 2, 3 |
| | | $+V_{CC} = 5V$, $-V_{CC} = -35V$, $V_{CM} = 15V$ | | -0.5 | 0.5 | mV | 1 |
| | | | | -1 | 1 | mV | 2, 3 |
| | | $+V_{CC} = +5V$, $-V_{CC} = -5V$ | | -0.5 | 0.5 | mV | 1 |
| | | | | -1 | 1 | mV | 2, 3 |
| Delta V_{IO} / Delta T | Temperature Coefficient of Input Offset Voltage | $25^\circ C \leq T_A \leq +125^\circ C$ | See ⁽¹⁾ | -5 | 5 | $\mu V/^\circ C$ | 2 |
| | | $25^\circ C \leq T_A \leq -55^\circ C$ | See ⁽¹⁾ | -5 | 5 | $\mu V/^\circ C$ | 3 |
| I_{IO} | Input Offset Current | $+V_{CC} = 35V$, $-V_{CC} = -5V$, $V_{CM} = -15V$ | | -0.2 | 0.2 | nA | 1 |
| | | | | -0.4 | 0.4 | nA | 2, 3 |
| | | $+V_{CC} = 5V$, $-V_{CC} = -35V$, $V_{CM} = 15V$ | | -0.2 | 0.2 | nA | 1 |
| | | | | -0.4 | 0.4 | nA | 2, 3 |
| | | $+V_{CC} = +5V$, $-V_{CC} = -5V$ | | -0.2 | 0.2 | nA | 1 |
| | | | | -0.4 | 0.4 | nA | 2, 3 |
| Delta I_{IO} / Delta T | Temperature Coefficient of Input Offset Current | $25^\circ C \leq T_A \leq +125^\circ C$ | See ⁽¹⁾ | -2.5 | 2.5 | $pA/^\circ C$ | 2 |
| | | $25^\circ C \leq T_A \leq -55^\circ C$ | See ⁽¹⁾ | -2.5 | 2.5 | $pA/^\circ C$ | 3 |

(1) Calculated parameter

LM108A Electrical Characteristics DC Parameters (continued)

The following conditions apply to all the following parameters, unless otherwise specified.

DC: $+V_{CC} = +20V$, $-V_{CC} = -20V$, $V_{CM} = 0V$, $R_S = 50\Omega$

| Symbol | Parameter | Conditions | Notes | Min | Max | Units | Sub-groups | | |
|-----------|------------------------|---|------------------------------|------------------------------------|-----|-------|------------|-----------|---------|
| $\pm I_B$ | Input Bias Current | $+V_{CC} = 35V$, $-V_{CC} = -5V$, $V_{CM} = -15V$ | | -0.1 | 2 | nA | 1 | | |
| | | | | -1 | 2 | nA | 2 | | |
| | | | | -0.1 | 3 | nA | 3 | | |
| | | $+V_{CC} = 5V$, $-V_{CC} = -35V$, $V_{CM} = 15V$ | | -0.1 | 2 | nA | 1 | | |
| | | | | -1 | 2 | nA | 2 | | |
| | | | | -0.1 | 3 | nA | 3 | | |
| | | $+V_{CC} = +5V$, $-V_{CC} = -5V$ | | -0.1 | 2 | nA | 1 | | |
| | | | | -1 | 2 | nA | 2 | | |
| | | | | -0.1 | 3 | nA | 3 | | |
| | | +PSRR | Power Supply Rejection Ratio | $+V_{CC} = 10V$, $-V_{CC} = -20V$ | | -16 | 16 | $\mu V/V$ | 1, 2, 3 |
| | | -PSRR | Power Supply Rejection Ratio | $+V_{CC} = 20V$, $-V_{CC} = -10V$ | | -16 | 16 | $\mu V/V$ | 1, 2, 3 |
| | | CMRR | Common Mode Rejection Ratio | $V_{CM} = \pm 15V$ | | 96 | | dB | 1, 2, 3 |
| $+I_{OS}$ | Short Circuit Current | $+V_{CC} = +15V$, $-V_{CC} = -15V$, $t \leq 25mS$ | | -20 | | mA | 1, 2, 3 | | |
| $-I_{OS}$ | Short Circuit Current | $+V_{CC} = +15V$, $-V_{CC} = -15V$, $t \leq 25mS$ | | | 20 | mA | 1, 2, 3 | | |
| I_{CC} | Power Supply Current | $+V_{CC} = +15V$, $-V_{CC} = -15V$ | | | 0.6 | mA | 1, 2 | | |
| | | | | | 0.8 | mA | 3 | | |
| $+V_{OP}$ | Output Voltage Swing | $R_L = 10K\Omega$ | | 16 | | V | 4, 5, 6 | | |
| $-V_{OP}$ | Output Voltage Swing | $R_L = 10K\Omega$ | | | -16 | V | 4, 5, 6 | | |
| $+A_{VS}$ | Open Loop Voltage Gain | $R_L = 10K\Omega$, $V_O = +15V$ | See ⁽²⁾ | 80 | | V/mV | 4 | | |
| | | | See ⁽²⁾ | 40 | | V/mV | 5, 6 | | |
| $-A_{VS}$ | Open Loop Voltage Gain | $R_L = 10K\Omega$, $V_O = -15V$ | See ⁽²⁾ | 80 | | V/mV | 4 | | |
| | | | See ⁽²⁾ | 40 | | V/mV | 5, 6 | | |
| A_{VS} | Open Loop Voltage Gain | $+V_{CC} = \pm 5V$, $R_L = 10K\Omega$, $V_O = \pm 2V$ | See ⁽²⁾ | 20 | | V/mV | 4, 5, 6 | | |

(2) Datalog reading in K = V/mV

LM108A Electrical Characteristics AC Parameters

The following conditions apply to all the following parameters, unless otherwise specified.

AC $+V_{CC} = +20V$, $-V_{CC} = -20V$, $V_{CM} = 0V$, $R_S = 50\Omega$

| Symbol | Parameter | Conditions | Notes | Min | Max | Units | Sub-groups |
|------------------|------------------------------|---|-------|------|------|------------|------------|
| TR _{TR} | Transient Response Rise Time | $R_L = 10K\Omega$, $C_L = 100pF$, $f < 1KHz$, $V_I = +50mV$ | | | 1000 | nS | 7, 8A, 8B |
| TR _{OS} | Transient Response Overshoot | $R_L = 10K\Omega$, $C_L = 100pF$, $f < 1KHz$, $V_I = +50mV$ | | | 50 | % | 7, 8A, 8B |
| +SR | Slew Rate | $A_V = 1$, $V_I = -5V$ to $+5V$ | | 0.05 | | V/ μ S | 7, 8A, 8B |
| -SR | Slew Rate | $A_V = 1$, $V_I = +5V$ to $-5V$ | | 0.05 | | V/ μ S | 7, 8A, 8B |
| NI _{BB} | Noise Broadband | $BW = 10Hz$ to $5KHz$, $R_S = 0\Omega$ | | | 15 | μ Vrms | 7 |
| NI _{PC} | Noise Popcorn | $BW = 10Hz$ to $5KHz$, $R_S = 100K\Omega$ | | | 40 | μ Vpk | 7 |

LM108A Electrical Characteristics DC Parameters Drift Values

The following conditions apply to all the following parameters, unless otherwise specified.

DC $+V_{CC} = +20V$, $-V_{CC} = -20V$, $V_{CM} = 0V$, $R_S = 50\Omega$

Delta calculations performed on JAN S devices at group B, Subgroup 5 only.

| Symbol | Parameter | Conditions | Notes | Min | Max | Units | Sub-groups |
|-----------------|----------------------|------------|-------|-------|------|-------|------------|
| V _{IO} | Input Offset Voltage | | | -0.25 | 0.25 | mV | 1 |
| $\pm I_B$ | Input Bias Current | | | -0.5 | 0.5 | nA | 1 |

Typical Performance Characteristics

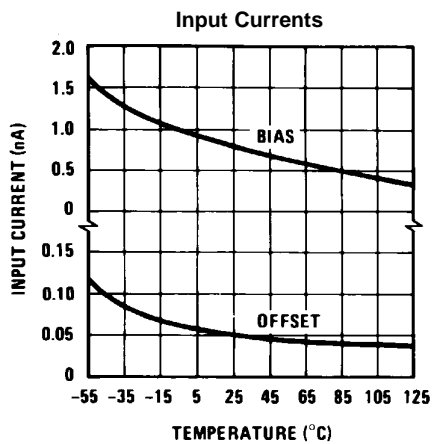


Figure 5.

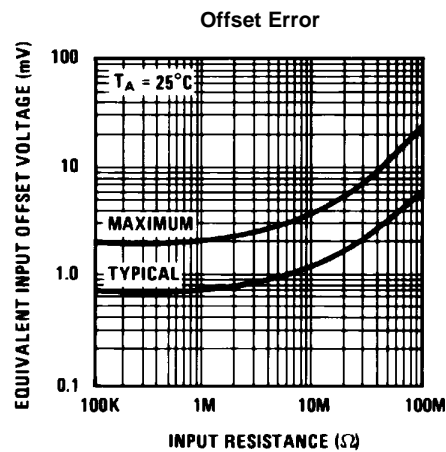


Figure 6.

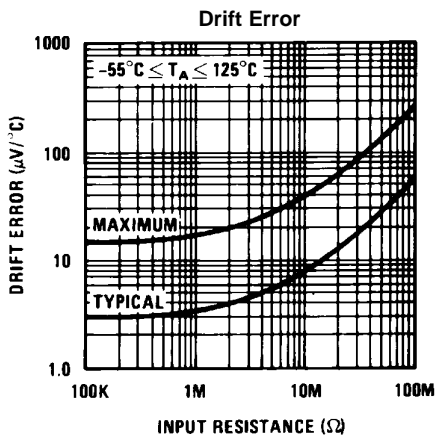


Figure 7.

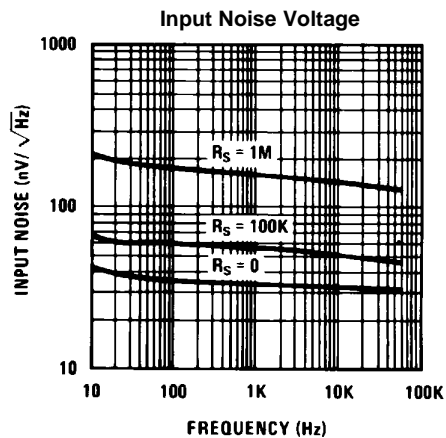


Figure 8.

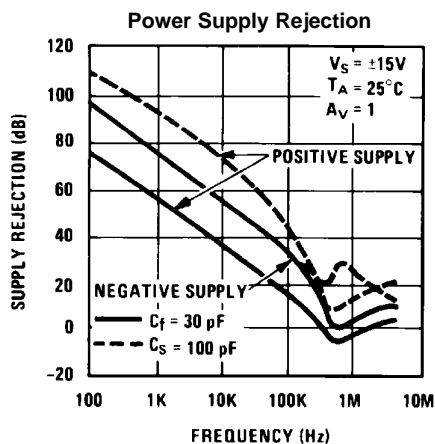


Figure 9.

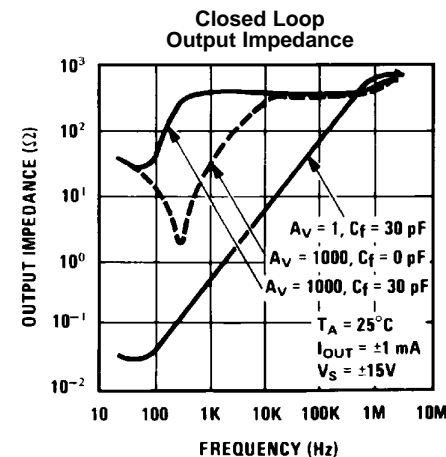


Figure 10.

Typical Performance Characteristics (continued)

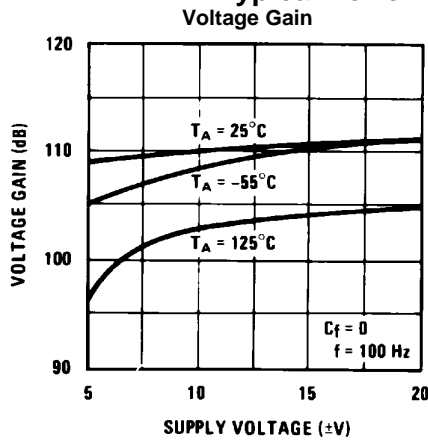


Figure 11.

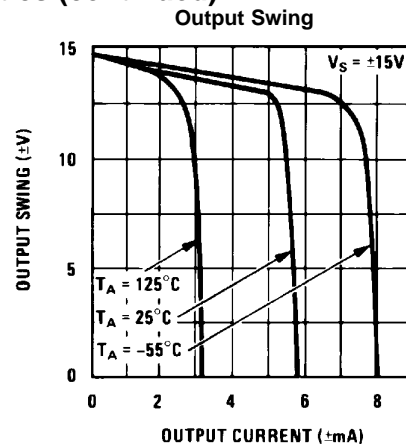


Figure 12.

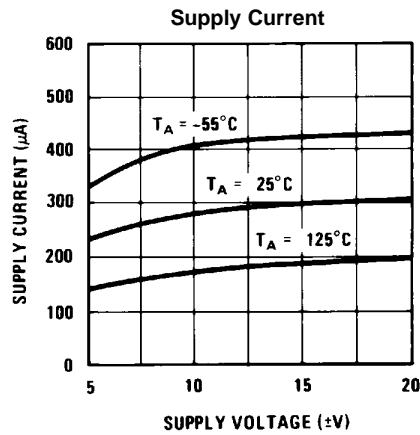


Figure 13.

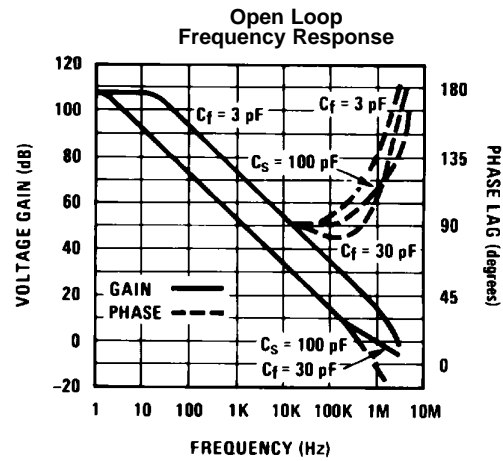


Figure 14.

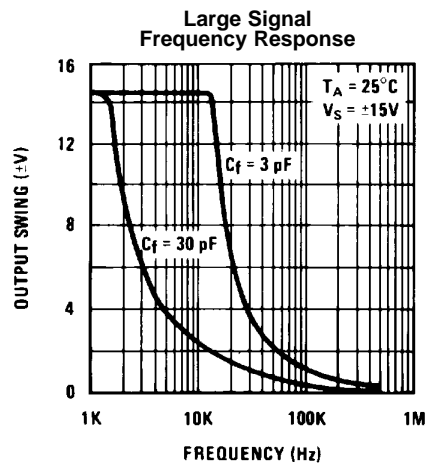


Figure 15.

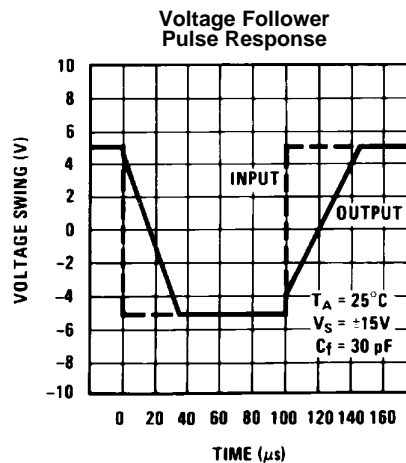
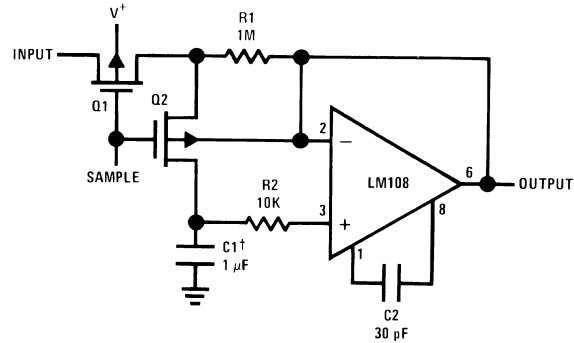


Figure 16.

Typical Applications



†Teflon polyethylene or polycarbonate dielectric capacitor
Worst case drift less than 2.5 mV/sec

Figure 17. Sample and Hold

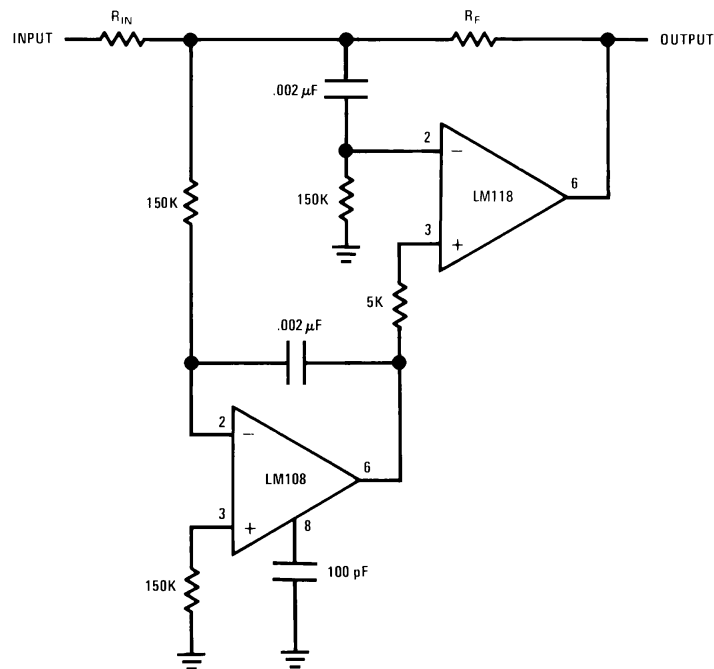
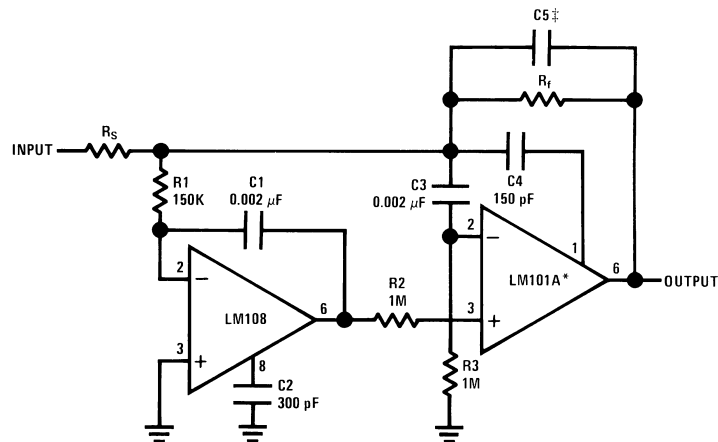


Figure 18. High Speed Amplifier with Low Drift and Low Input Current



$$C5 = \frac{6 \times 10^{-8}}{R_f}$$

*In addition to increasing speed, the LM101A raises high and low frequency gain, increases output drive capability and eliminates thermal feedback.

Power Bandwidth: 250 KHz Small Signal Bandwidth: 3.5 MHz Slew Rate: 10V/μS

Figure 19. Fast Summing Amplifier

REVISION HISTORY

| Date Released | Revision | Section | Changes |
|---------------|----------|-------------------------------|--|
| 02/25/05 | A | New release, corporate format | 1 MDS data sheets converted into one Corp. datasheet format. MJLM108A-X Rev 2A0. MDS will be archived. |
| 01/05/06 | B | DC Electrical's | All temps. +Ios from -15 mA Min to -20 mA Min and -Ios from +15 mA Max to +20 mA Max |
| 09/24/10 | C | Obsolete Data Sheet | Revision C, End of Life on Product/NSID Dec. 2008/09 Obsolete Data Sheet |

Changes from Revision B (April 2013) to Revision C

Page

- Changed layout of National Data Sheet to TI format 11

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