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 µA, even in saturation**
- **Guaranteed drift characteristics**

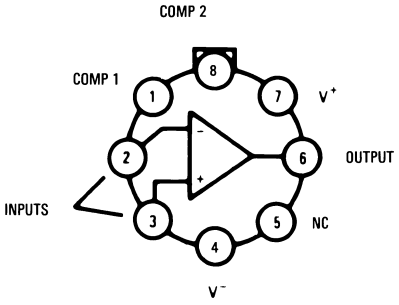
DESCRIPTION

The LM108 is a precision operational amplifier having specifications a factor of ten better than FET amplifiers over a −55°C to +125°C temperature range.

The devices operate with supply voltages from ±2V to ±20V 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 MΩ source resistances, introducing less error than devices such as the 709 with 10 kΩ sources. Integrators with drifts less than 500 µV/sec and analog time delays in excess of one hour can be made using capacitors no larger than 1 µF.

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 - Package Number H08C

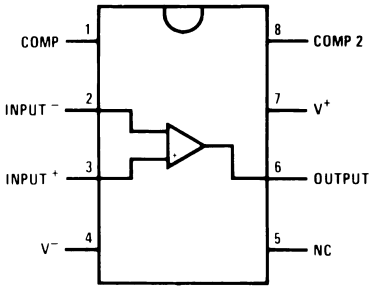


Figure 2. Dual-In-Line Package – Top View – Package Number J08A

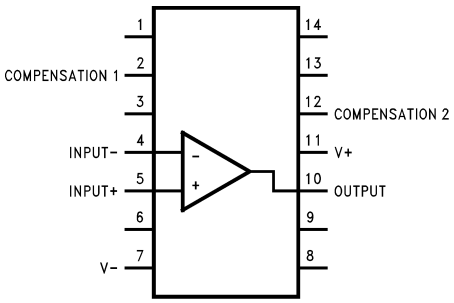


Figure 3. Top View – Package Number J14A

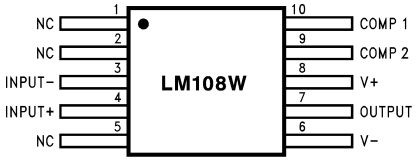
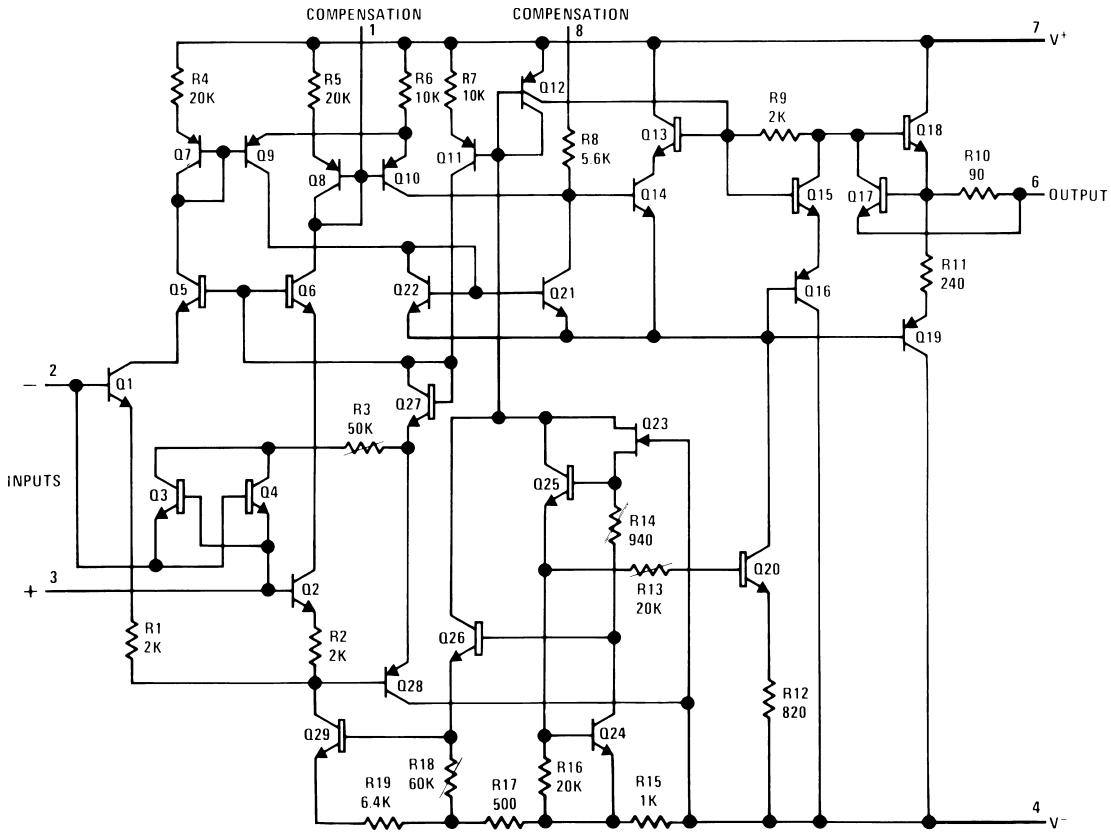


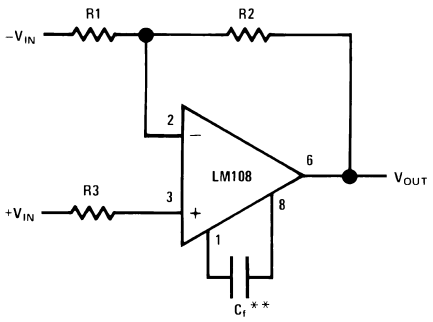
Figure 4. Top View – Package Number W10A, WG10A

Schematic Diagram



Compensation Circuits

Figure 5. Standard Compensation Circuit

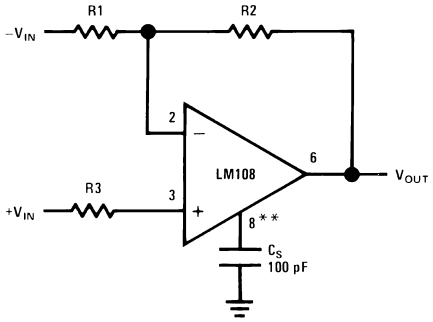


$$C_f \geq \frac{R1\ C_O}{R1 + R2}$$

C_O = 30 pF

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

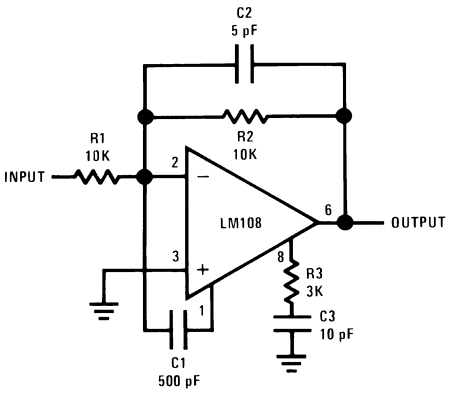
Figure 6. Alternate Frequency Compensation



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

(1) Improves rejection of power supply noise by a factor of ten.

Figure 7. 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 (1)	
Metal Can 8LD	330mW @ +125°C
CERDIP 14LD	400mW @ +125°C
CERDIP 8LD	400mW @ +125°C
CERPACK 10LD	330mW @ +125°C
Ceramic SOIC 10LD	330mW @ +125°C
Differential Input Current (2)	±10 mA
Differential Input Voltage (3)	±30V
Input Voltage (4)	±20V
Output Short-Circuit Duration	Continuous
Operating Temperature Range	$-55°C \leq T_A \leq +125°C$
Storage Temperature Range	$-65°C \leq T_A \leq +150°C$
Thermal Resistance θ_{JA}	
Metal Can 8LD Still Air 500LF / Min Air Flow	150°C/W 86°C/W
CERDIP 14LD Still Air 500LF / Min Air Flow	94°C/W 55°C/W
CERDIP 8LD Still Air 500LF / Min Air Flow	120°C/W 68°C/W
CERPACK 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}	
Metal Can 8LD	38°C/W
CERDIP 14LD	13°C/W
CERDIP 8LD	17°C/W
CERPACK 10LD	21°C/W
Ceramic SOIC 10LD	21°C/W
Package Weight (typical)	
Metal Can 8LD	990mg
CERDIP 14LD	2,180mg
CERDIP 8LD	1,090mg
CERPACK 10LD	225mg
Ceramic SOIC 10LD	210mg
Maximum Junction Teperature	175°C
Lead Temperature (Soldering, 10 sec)	300°C
ESD Tolerance (5)	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 guarantee specific performance limits. For guaranteed specifications and test conditions, see the Electrical Characteristics. The guaranteed specifications apply only for the test conditions listed. Some performance characteristics may degrade when the device is not operated under the listed test conditions.

(1) The maximum power dissipation must be derated at elevated temperatures and is dictated by $T_J$max (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 $P_D$max = ($T_J$max - T_A) /θ_{JA} or the number given in the Absolute Maximum Ratings, whichever is lower.

(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 1V is applied between the inputs unless some limiting resistance is used.

(3) 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.

(4) For supply voltages less than ±20V, the absolute maximum input voltage is equal to the supply voltage.

(5) Human body model, 1.5 kΩ in series with 100 pF.

Table 1. Quality Conformance InspectionMil-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 = 50Ω

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
				-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 Coeffient of Input Offset Voltage	25°C ≤ T_A ≤ +125°C	(1)	-5	5	µV/°C	2
		25°C ≤ T_A ≤ -55°C	(1)	-5	5	µV/°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
				-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 Coeffient of Input Offset Current	25°C ≤ T_A ≤ +125°C	(1)	-2.5	2.5	pA/°C	2
		25°C ≤ T_A ≤ -55°C	(1)	-2.5	2.5	pA/°C	3
$\pm I_{IB}$	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
				-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	µV/V	1, 2, 3
-PSRR	Power Supply Rejection Ratio	$+V_{CC}$ = 20V, $-V_{CC}$ = -10V		-16	16	µV/V	1, 2, 3
CMRR	Common Mode Rejection Ratio	V_{CM} = ±15V		96		dB	1, 2, 3
$+I_{OS}$	Short Circuit Current	$+V_{CC}$ = +15V, $-V_{CC}$ = -15V, t ≤ 25mS		-20		mA	1, 2, 3
$-I_{OS}$	Short Circuit Current	$+V_{CC}$ = +15V, $-V_{CC}$ = -15V, t ≤ 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 = 10KΩ		16		V	4, 5, 6
$-V_{OP}$	Output Voltage Swing	R_L = 10KΩ			-16	V	4, 5, 6

(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 = 50Ω

Symbol	Parameter	Conditions	Notes	Min	Max	Units	Sub-groups
$+A_{VS}$	Open Loop Voltage Gain	R_L = 10KΩ, V_O = +15V	(2)	80		V/mV	4
			(2)	40		V/mV	5, 6
$-A_{VS}$	Open Loop Voltage Gain	R_L = 10KΩ, V_O = -15V	(2)	80		V/mV	4
			(2)	40		V/mV	5, 6
A_{VS}	Open Loop Voltage Gain	$+V_{CC}$ = ±5V, R_L = 10KΩ, V_O = ±2V	(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/µS	7, 8A, 8B
−SR	Slew Rate	$A_V = 1$, $V_I = +5V$ to $-5V$		0.05		V/µS	7, 8A, 8B
NI_{BB}	Noise Broadband	BW = 10Hz to 5KHz, $R_S = 0\Omega$			15	µVrms	7
NI_{PC}	Noise Popcorn	BW = 10Hz to 5KHz, $R_S = 100K\Omega$			40	µVpk	7

LM108A Electrical Characteristics DC Parameters Drift Values

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

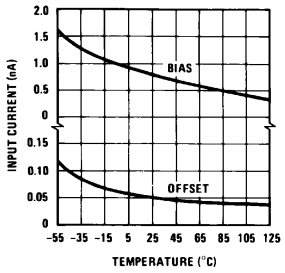
DC $+V_{CC} = +20V$, $-V_{CC} = -20V$, $V_{CM} = 0V$, $R_S = 50\Omega$

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

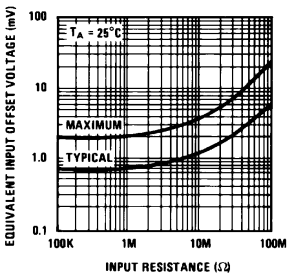
Symbol	Parameter	Conditions	Notes	Min	Max	Units	Sub-groups
V_{IO}	Input Offset Voltage			-0.25	0.25	mV	1
$\pm I_{IB}$	Input Bias Current			-0.5	0.5	nA	1

Typical Performance Characteristics

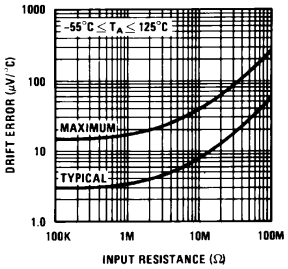
Input Currents



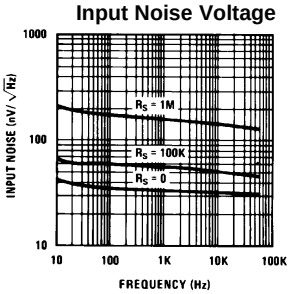
Offset Error



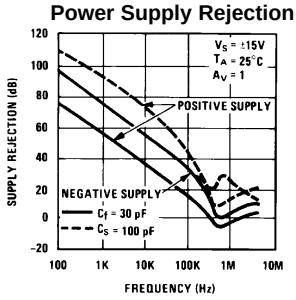
Drift Error



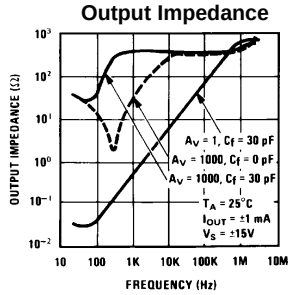
Input Noise Voltage



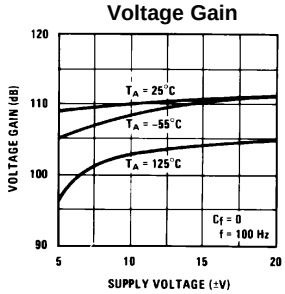
Power Supply Rejection



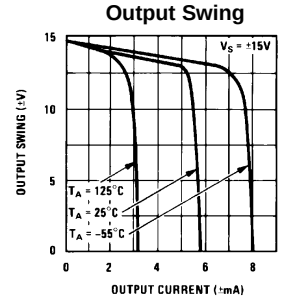
Closed Loop Output Impedance



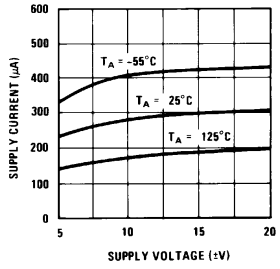
Voltage Gain



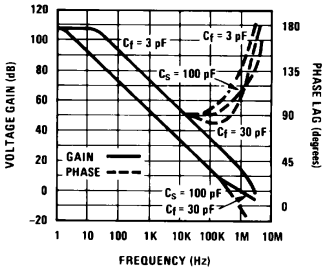
Output Swing



Supply Current

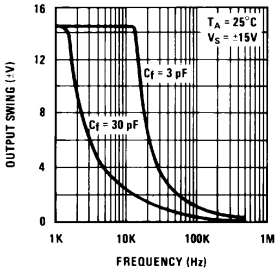


Open Loop Frequency Response

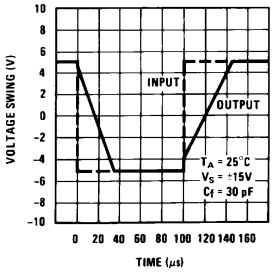


Typical Performance Characteristics (continued)

Large Signal Frequency Response

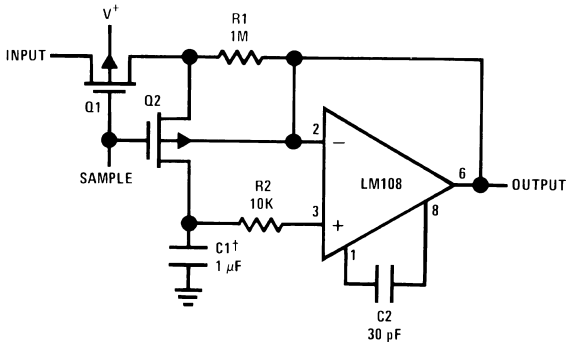


Voltage Follower Pulse Response



Typical Applications

Figure 8. Sample and Hold



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

Figure 9. High Speed Amplifier with Low Drift and Low Input Current

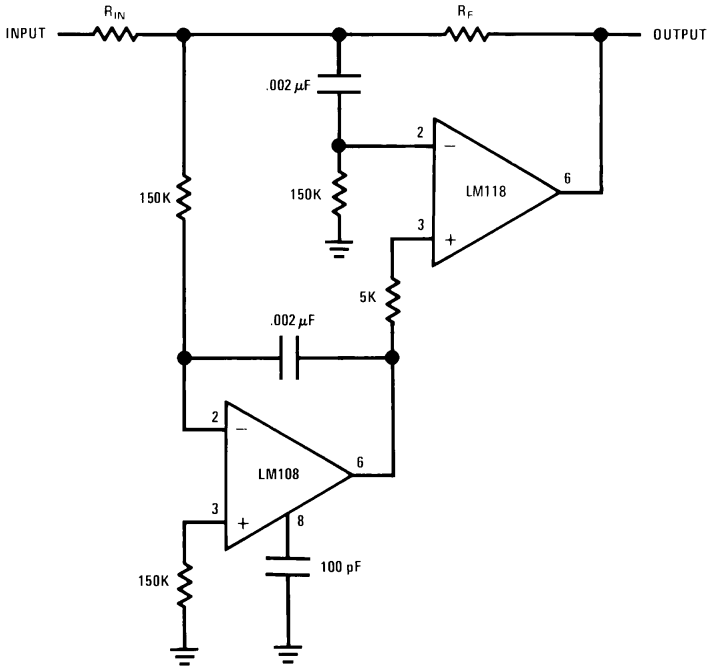
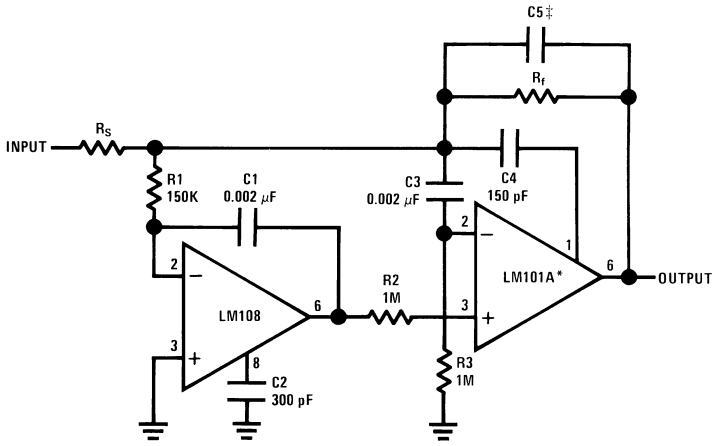


Figure 10. Fast Summing Amplifier



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

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

(1) Power Bandwidth: 250 KHzSmall Signal Bandwidth: 3.5 MHzSlew Rate: 10V/µS

REVISION HISTORY SECTION

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

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