National Semiconductor

February 1995

LM709 Operational Amplifier

General Description

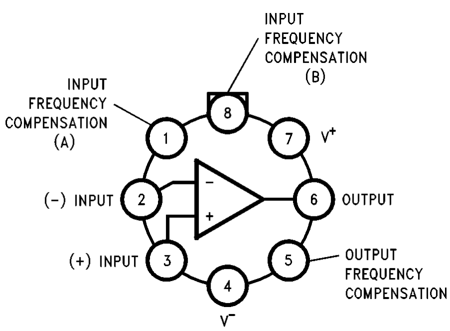
The LM709 series is a monolithic operational amplifier intended for general-purpose applications. Operation is completely specified over the range of voltages commonly used for these devices. The design, in addition to providing high gain, minimizes both offset voltage and bias currents. Further, the class-B output stage gives a large output capability with minimum power drain.

External components are used to frequency compensate the amplifier. Although the unity-gain compensation network specified will make the amplifier unconditionally stable in all feedback configurations, compensation can be tailored to optimize high-frequency performance for any gain setting.

The LM709C is the commercial-industrial version of the LM709. It is identical to the LM709 except that it is specified for operation from 0°C to +70°C.

Connection Diagrams

Metal Can Package



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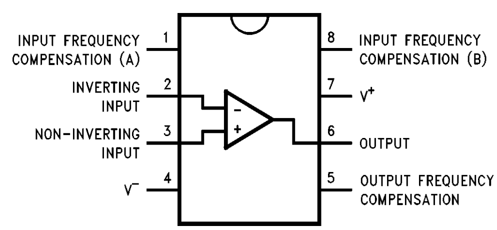
Order Number LM709AH, LM709H or LM709CH
See NS Package Number H08C

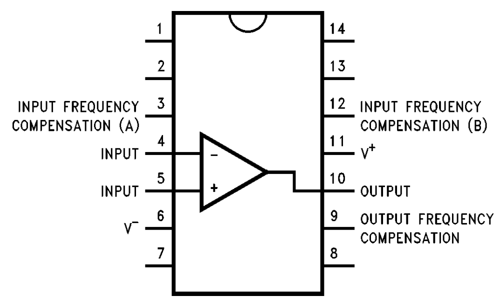
Dual-In-Line Package



TL/H/11477–6

Order Number LM709CN-8
See NS Package Number N08E

Dual-In-Line Package



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Order Number LM709CN
See NS Package Number N14A

Absolute Maximum Ratings (Note 3)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

Supply Voltage	
LM709/LM709A/LM709C	±18V
Power Dissipation (Note 1)	
LM709/LM709A	300 mW
LM709C	250 mW
Differential Input Voltage	
LM709/LM709A/LM709C	±5V
Input Voltage	
LM709/LM709A/LM709C	±10V
Output Short-Circuit Duration (T_A = +25°C)	
LM709/LM709A/LM709C	5 seconds
Storage Temperature Range	
LM709/LM709A/LM709C	−65°C to +150°C
Lead Temperature (Soldering, 10 sec.)	
LM709/LM709A/LM709C	300°C

Operating Ratings (Note 3)

Junction Temperature Range (Note 1)	
LM709/LM709A	−55°C to +150°C
LM709C	0°C to +100°C
Thermal Resistance (θ_{JA})	
H Package	150°C/W, (θ_{JC}) 45°C/W
8-Pin N Package	134°C/W
14-Pin N Package	109°C/W

Electrical Characteristics (Note 2)

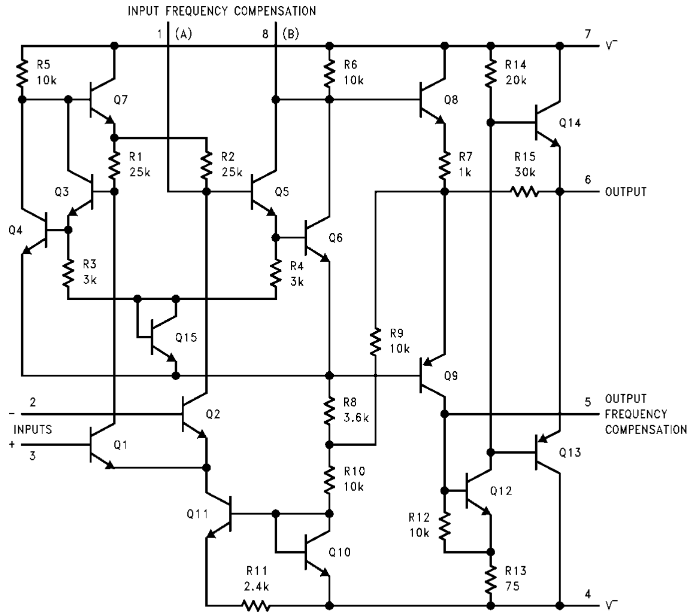
Parameter	Conditions	LM709A			LM709			LM709C			Units
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Input Offset Voltage	T_A = 25°C, R_S ≤ 10 kΩ		0.6	2.0		1.0	5.0		2.0	7.5	mV
Input Bias Current	T_A = 25°C		100	200		200	500		300	1500	nA
Input Offset Current	T_A = 25°C		10	50		50	200		100	500	nA
Input Resistance	T_A = 25°C	350	700		150	400		50	250		kΩ
Output Resistance	T_A = 25°C		150			150			150		Ω
Supply Current	T_A = 25°C, V_S = ±15V		2.5	3.6		2.6	5.5		2.6	6.6	mA
Transient Response Risetime Overshoot	V_{IN} = 20 mV, C_L ≤ 100 pF T_A = 25°C			 1.5 30		 0.3 10	 1.0 30		 0.3 10	 1.0 30	 μs %
Slew Rate	T_A = 25°C		0.25			0.25			0.25		V/μs
Input Offset Voltage	R_S ≤ 10 kΩ			3.0			6.0			10	mV
Average Temperature Coefficient of Input Offset Voltage	R_S = 50Ω, T_A = 25°C to T_{MAX} T_A = 25°C to T_{MIN} R_S = 10 kΩ, T_A = 25°C to T_{MAX} T_A = 25°C to T_{MIN}		1.8 1.8 2.0 4.8	10 10 15 25		3.0 6.0			6.0 12		μV/°C
Large Signal Voltage Gain	V_S = ±15V, R_L ≥ 2 kΩ V_{OUT} = ±10V	25		70	25	45	70	15	45		V/mV
Output Voltage Swing	V_S = ±15V, R_L = 10 kΩ V_S = ±15V, R_L = 2 kΩ	±12 ±10	±14 ±13		±12 ±10	±14 ±13		±12 ±10	±14 ±13		V
Input Voltage Range	V_S = ±15V	±8			±8	±10		±8	±10		V
Common-Mode Rejection Ratio	R_S ≤ 10 kΩ	80	110		70	90		65	90		dB
Supply Voltage Rejection Ratio	R_S ≤ 10 kΩ		40	100		25	150		25	200	μV/V
Input Offset Current	T_A = T_{MAX} T_A = T_{MIN}		3.5 40	50 250		20 100	200 500		75 125	400 750	nA
Input Bias Current	T_A = T_{MIN}		0.3	0.6		0.5	1.5		0.36	2.0	μA
Input Resistance	T_A = T_{MIN}	85	170		40	100		50	250		kΩ

Note 1: For operating at elevated temperatures, the device must be derated based on a 150°C maximum junction temperature for LM709/LM709A and 100°C maximum for L709C. For operating at elevated temperatures, the device must be derated based on thermal resistance θ_{JA}, $T_{J(MAX)}$ and T_A.

Note 2: These specifications apply for −55°C ≤ T_A ≤ +125°C for the LM709/LM709A and 0°C ≤ T_A ≤ +70°C for the LM709C with the following conditions: ±9V ≤ V_S ≤ ±15V, C1 = 5000 pF, R1 = 1.5 kΩ, C2 = 200 pF and R2 = 51Ω.

Note 3: Absolute Maximum Ratings indicate limits which if exceeded may result in damage. Operating Ratings are conditions where the device is expected to be functional but not necessarily within the guaranteed performance limits. For guaranteed specifications and test conditions, see the Electrical Characteristics.

Schematic Diagram**



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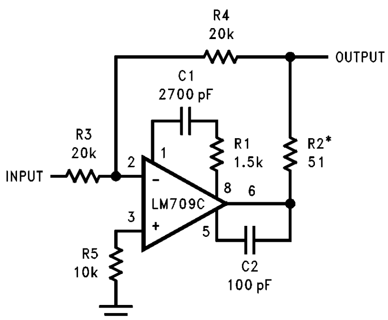
Typical Applications**

Unity Gain Inverting Amplifier



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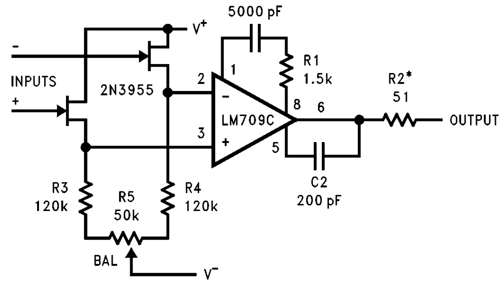
FET Operational Amplifier



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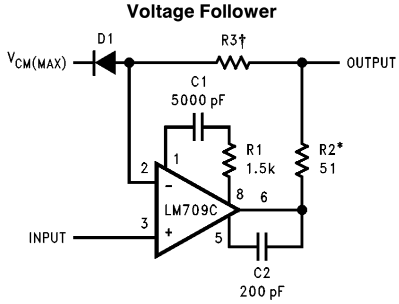
Voltage Follower



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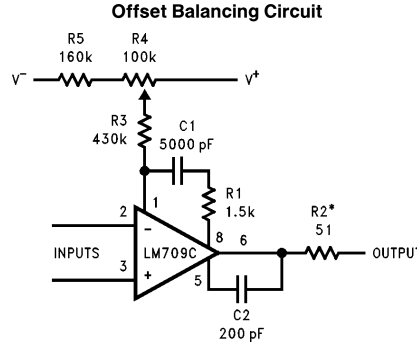
Offset Balancing Circuit



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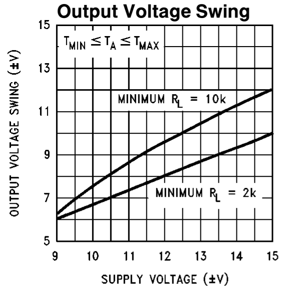
*To be used with any capacitive loading on output.

**Pin connections shown are for metal can package.

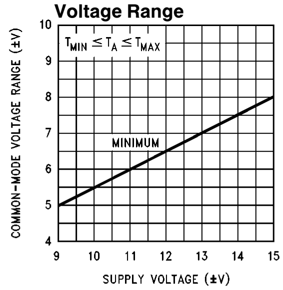
†Should be equal to DC source resistance on input.

Guaranteed Performance Characteristics

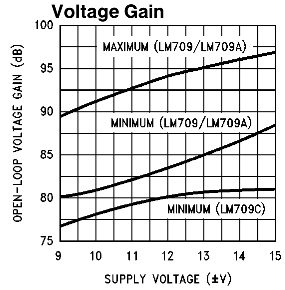
Output Voltage Swing



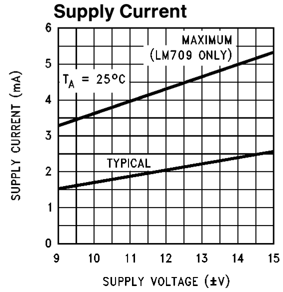
Input Common-Mode Voltage Range



Voltage Gain



Supply Current



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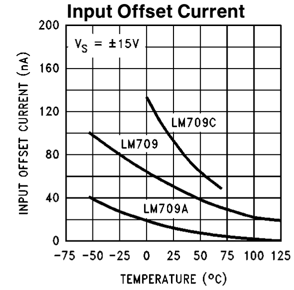
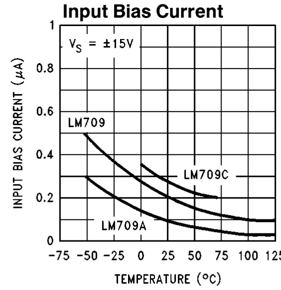
Typical Performance Characteristics

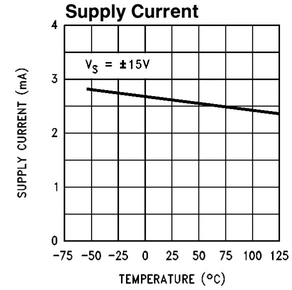
Input Offset Current



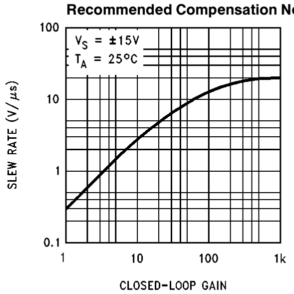
Input Bias Current



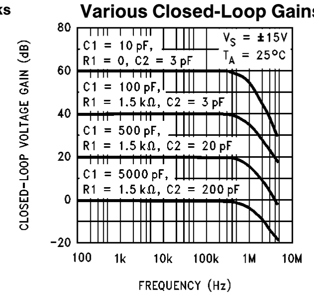
Supply Current



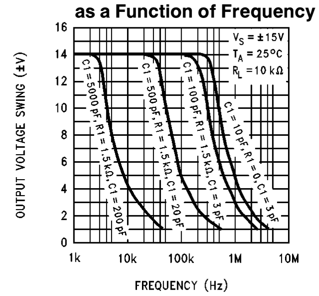
Slew Rate as a Function of Closed-Loop Gain Using Recommended Compensation Networks



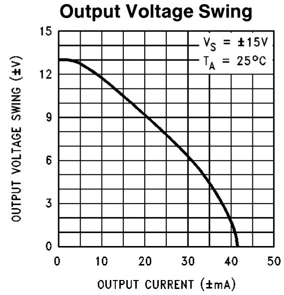
Frequency Response for Various Closed-Loop Gains



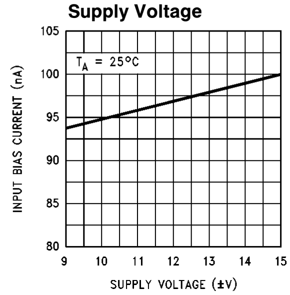
Output Voltage Swing as a Function of Frequency



Output Voltage Swing



Input Bias Current as a Function of Supply Voltage



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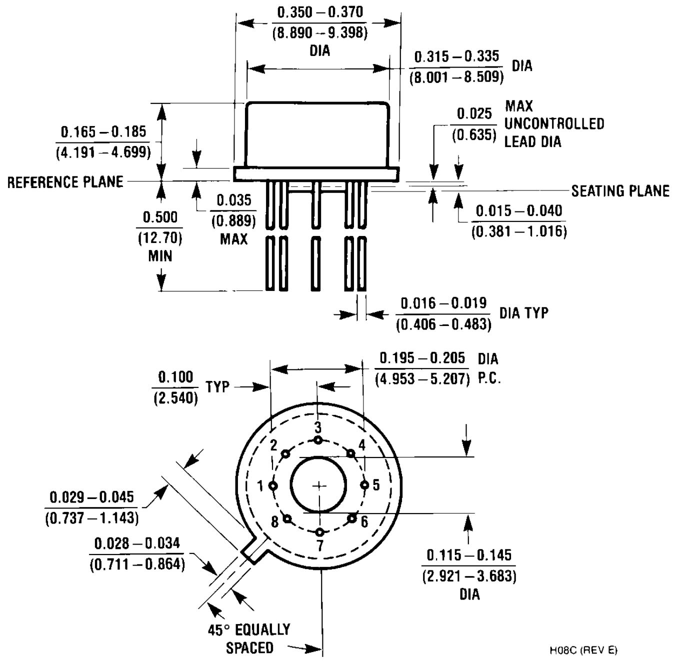
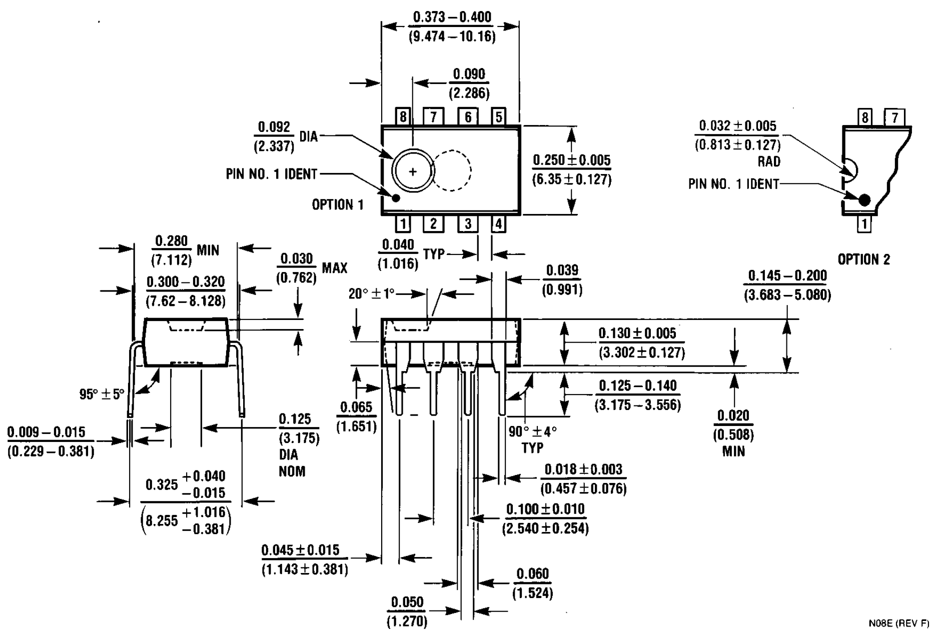
Physical Dimensions inches (millimeters)

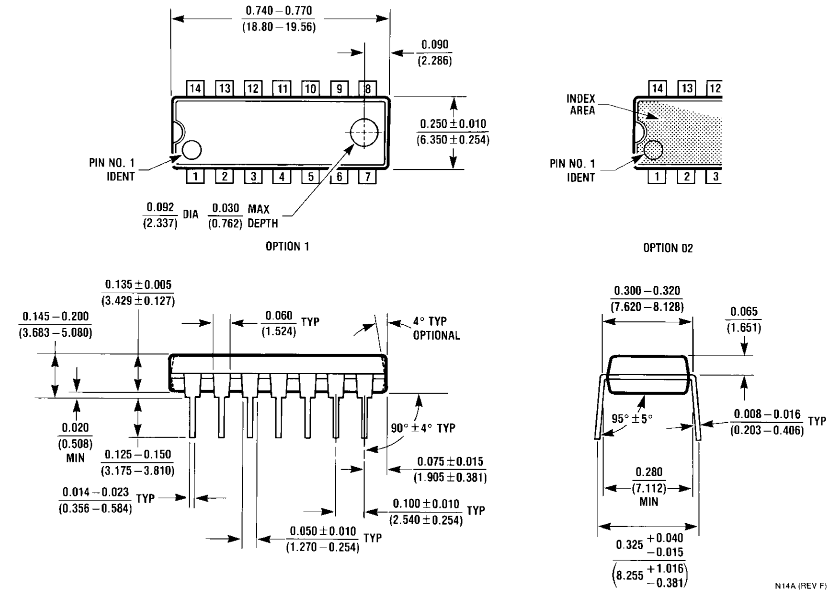


Metal Can Package (H)
Order Number LM709AH, LM709H or LM709CH
NS Package Number H08C



8-Lead Molded Dual-In-Line Package (N)
Order Number LM709CN-8
NS Package Number N08E

Physical Dimensions inches (millimeters) (Continued)



14-Lead Molded Dual-In-Line Package (N)
Order Number LM709CN
NS Package Number N14A

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