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LM709 Operational Amplifier

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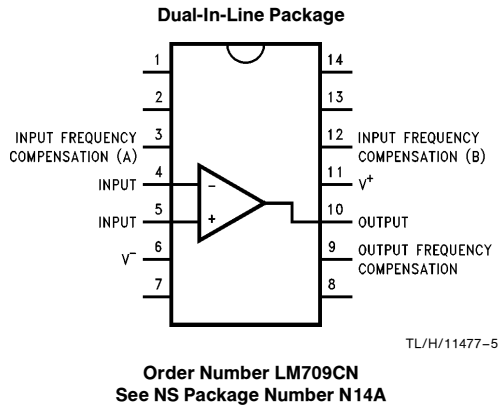
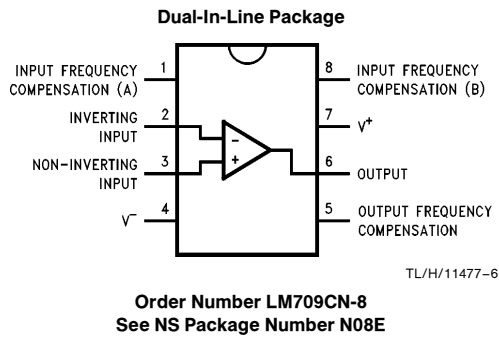
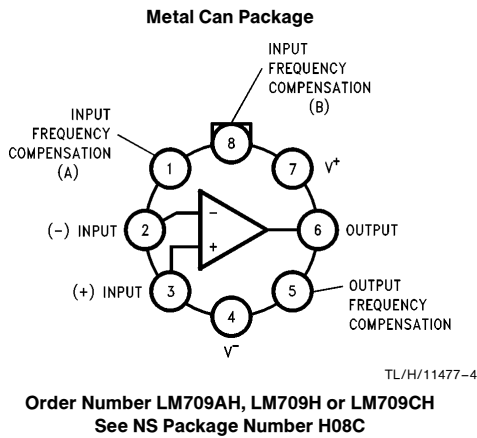
## General Description

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



## 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 LM709C	300 mW 250 mW
Differential Input Voltage LM709/LM709A/LM709C	±5V
Input Voltage LM709/LM709A/LM709C	±10V
Output Short-Circuit Duration ( $T_A = +25^\circ\text{C}$ ) 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 LM709C	-55°C to +150°C 0°C to +100°C
Thermal Resistance ( $\theta_{JA}$ ) H Package 8-Pin N Package 14-Pin N Package	150°C/W, ( $\theta_{JC}$ ) 45°C/W 134°C/W 109°C/W

## Electrical Characteristics (Note 2)

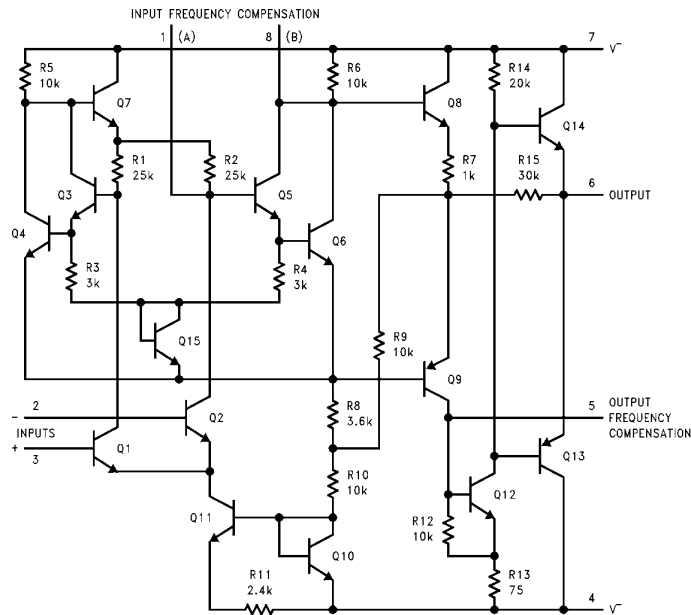
Parameter	Conditions	LM709A			LM709			LM709C			Units
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
Input Offset Voltage	$T_A = 25^\circ\text{C}$ , $R_S \leq 10\text{ k}\Omega$	0.6	2.0		1.0	5.0		2.0	7.5		mV
Input Bias Current	$T_A = 25^\circ\text{C}$	100	200		200	500		300	1500		nA
Input Offset Current	$T_A =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

**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  $\theta_{JA}$ ,  $T_{J(MAX)}$  and  $T_A$ .

**Note 2:** These specifications apply for  $-55^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$  for the LM709/LM709A and  $0^\circ\text{C} \leq T_A \leq +70^\circ\text{C}$  for the LM709C with the following conditions:  $\pm 9\text{V} \leq V_S \leq \pm 15\text{V}$ ,  $C_1 = 5000\text{ pF}$ ,  $R_1 = 1.5\text{ k}\Omega$ ,  $C_2 = 200\text{ pF}$  and  $R_2 = 51\Omega$ .

**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.

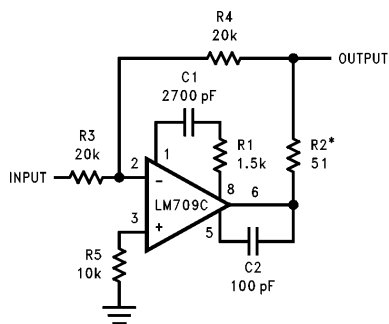
## Schematic Diagram\*\*



TL/H/11477-1

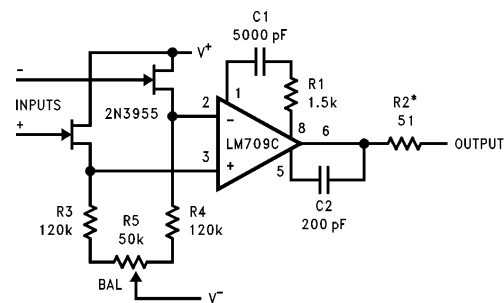
## Typical Applications\*\*

### Unity Gain Inverting Amplifier



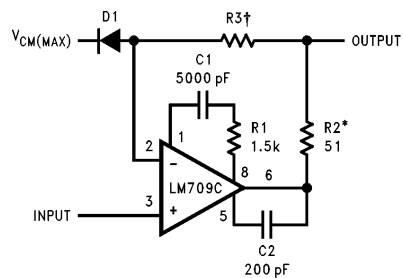
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### FET Operational Amplifier



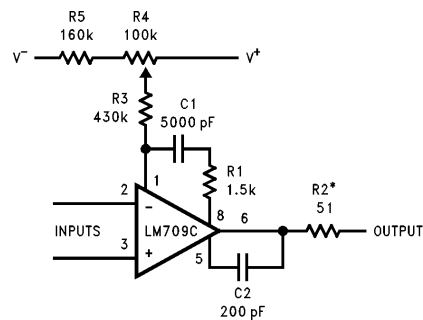
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### Voltage Follower



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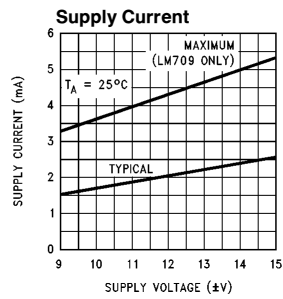
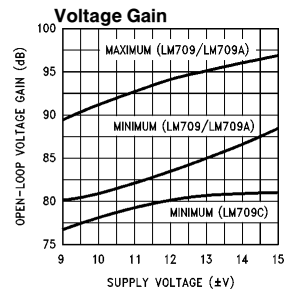
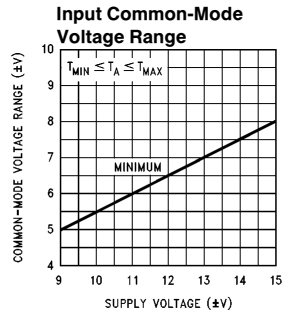
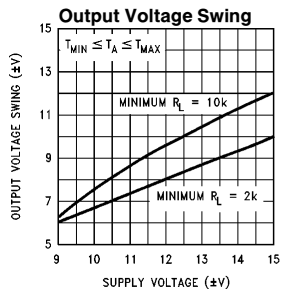
### Offset Balancing Circuit



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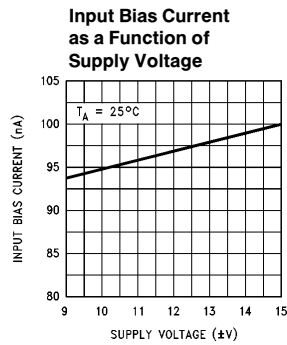
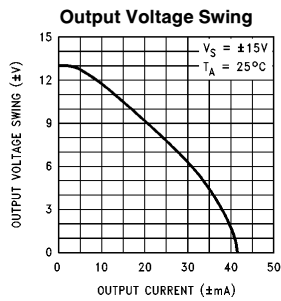
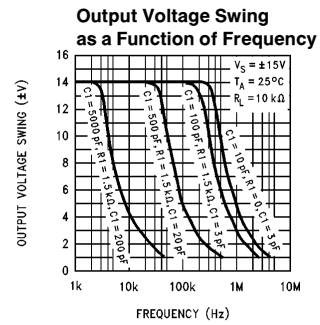
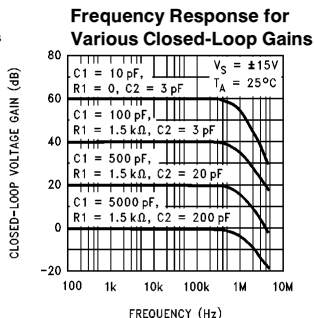
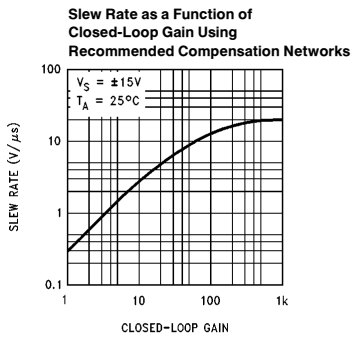
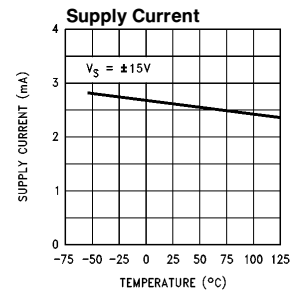
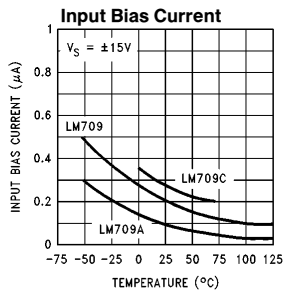
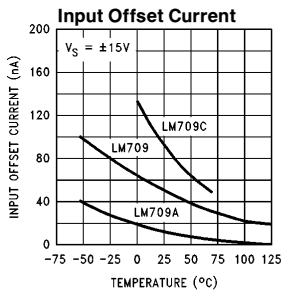
\*To be used with any capacitive loading on output.  
 \*\*Pin connections shown are for metal can package.  
 †Should be equal to DC source resistance on input.

# Guaranteed Performance Characteristics



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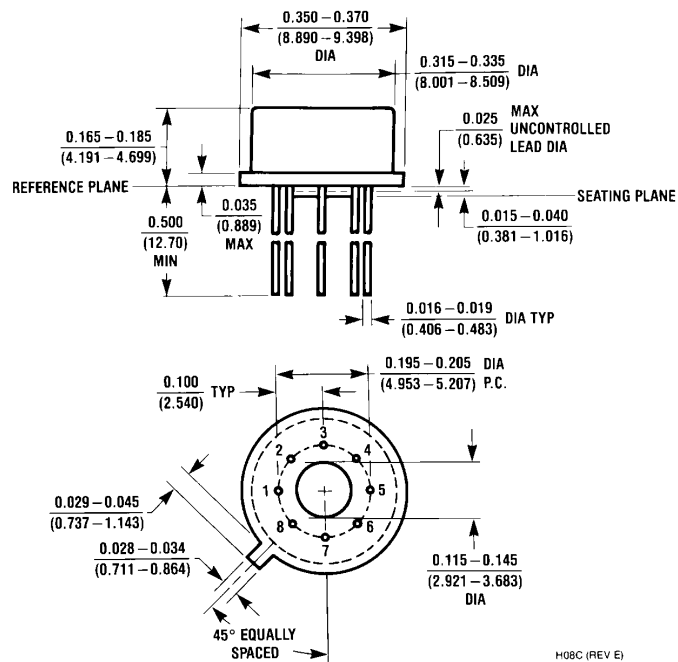
# Typical Performance Characteristics



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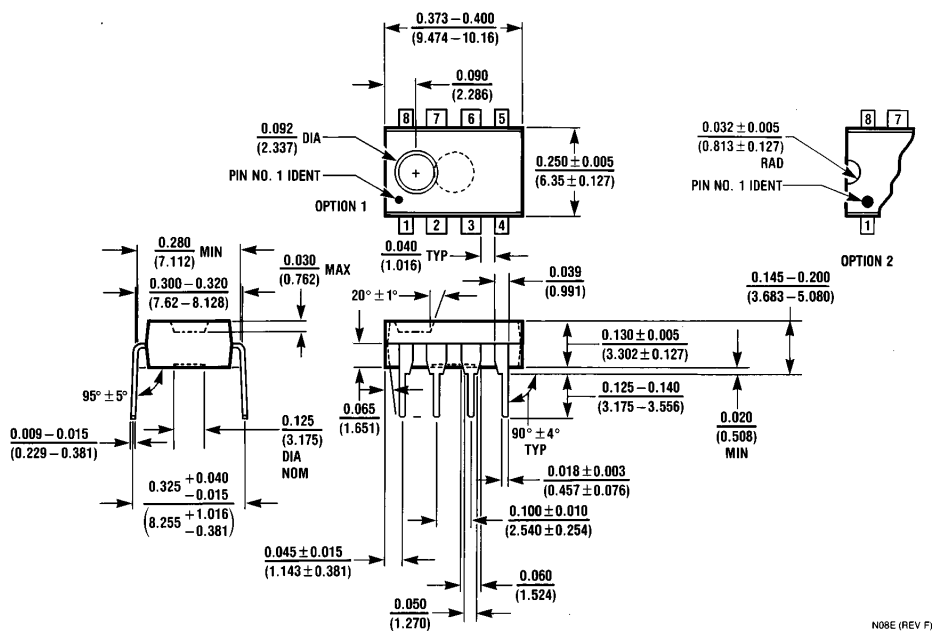


**Physical Dimensions** inches (millimeters)



H08C (REV E)

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



N08E (REV F)

**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**

N14A (REV F)

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