

# μA709

## HIGH PERFORMANCE OPERATIONAL AMPLIFIER

### FAIRCHILD LINEAR INTEGRATED CIRCUITS

**GENERAL DESCRIPTION** — The μA709 is a high gain operational amplifier constructed on a single silicon chip using the Fairchild Planar\* epitaxial process. It features low offset, high input impedance, large input common mode range, high output swing under load and low power consumption. The device displays exceptional temperature stability and will operate over a wide range of supply voltages with little degradation of performance. The amplifier is intended for use in DC servo systems, high impedance analog computers, low-level instrumentation applications and for the generation of special linear and nonlinear transfer functions.

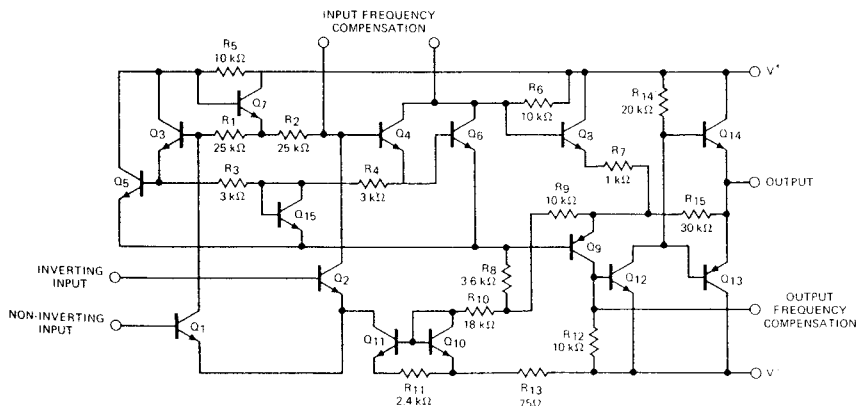
#### ABSOLUTE MAXIMUM RATINGS

Supply Voltage	± 18 V
Internal Power Dissipation (Note)	
Metal Can	500 mW
Ceramic DIP	670 mW
Flatpak	570 mW
Differential Input Voltage	± 5.0 V
Input Voltage	± 10 V
Storage Temperature Range	
Metal Can, Ceramic DIP, and Flatpak	-65°C to +150°C
Operating Temperature Range	
Military (311 and 312 Grades)	-55°C to +125°C
Commerical (393 Grade)	0°C to +70°C
Lead Temperature	
Metal Can, Ceramic DIP and Flatpak (Soldering 60 seconds)	300°C
Output Short Circuit Duration	5 seconds

#### NOTE

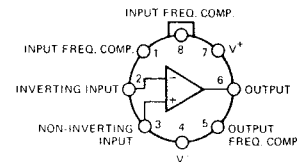
Rating applies to ambient temperatures up to 70°C. Above 70°C ambient derate linearly at 6.3 mW/°C for Metal Can, 6.3 mW/°C for Silicone DIP, 8.3 mW/°C for Ceramic DIP and 7.1 mW/°C for the Flatpak package.

#### EQUIVALENT CIRCUIT



#### CONNECTION DIAGRAMS (TOP VIEWS)

##### 8 LEAD METAL CAN

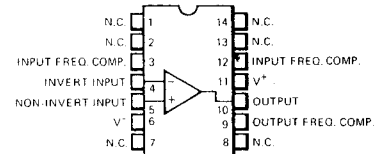


NOTE: Pin 4 connected to case

##### ORDER PART NOS.:

**U5B7709311**  
**U5B7709312**  
**U5B7709393**

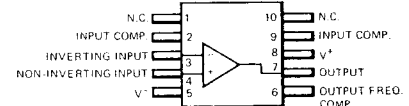
##### 14 LEAD DIP



##### ORDER PART NOS.:

**U6A7709311**  
**U6A7709312**  
**U6A7709393**

##### FLATPAK



##### ORDER PART NOS.:

**U3F7709311**  
**U3F7709312**

\* Planar is a patented Fairchild process.

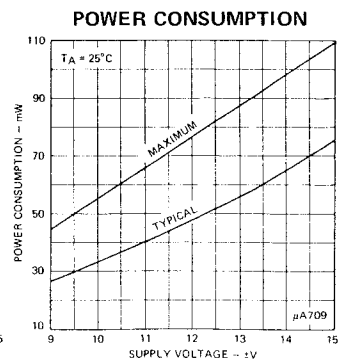
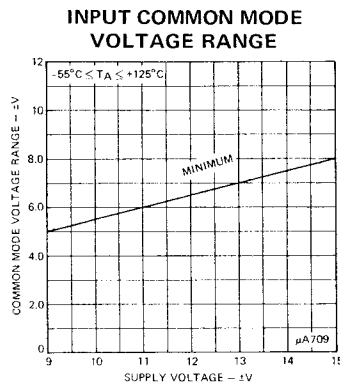
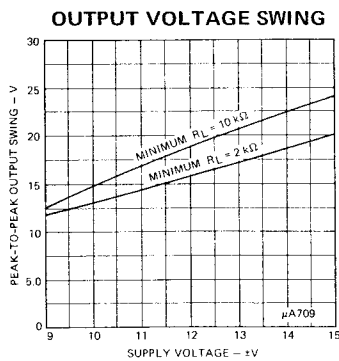
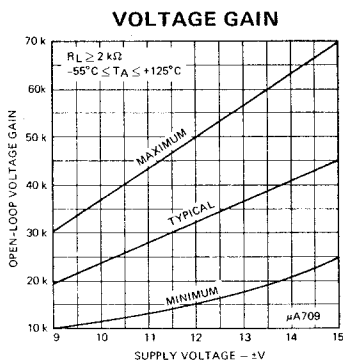
(311 GRADE)

ELECTRICAL CHARACTERISTICS ( $T_A = +25^\circ C$ ,  $\pm 9 V \leq V_S \leq \pm 15 V$  unless otherwise specified)

PARAMETER (see definitions)	CONDITIONS	MIN.	TYP.	MAX.	UNITS
Input Offset Voltage	$R_S \leq 10 k\Omega$		0.6	2.0	mV
Input Offset Current			10	50	nA
Input Bias Current			100	200	nA
Input Resistance		350	700		$k\Omega$
Output Resistance			150		$\Omega$
Supply Current	$V_S = \pm 15 V$		2.5	3.6	mA
Power Consumption	$V_S = \pm 15 V$		75	108	mW
Transient Response	$V_S = \pm 15 V$ , $V_{IN} = 20 mV$ , $R_L = 2 k\Omega$ , $C_1 = 5 nF$ , $R_1 = 1.5 k\Omega$ , $C_2 = 200 pF$ , $R_2 = 50\Omega$				
Risetime				1.5	$\mu s$
Overshoot	$C_L \leq 100 pF$			30	%
The following specifications apply for $-55^\circ C \leq T_A \leq +125^\circ C$ :					
Input Offset Voltage	$R_S \leq 10 k\Omega$			3.0	mV
Average Temperature Coefficient of Input Offset Voltage	$R_S = 50\Omega$ , $T_A = +25^\circ C$ to $+125^\circ C$		1.8	10	$\mu V/^\circ C$
	$R_S = 50\Omega$ , $T_A = +25^\circ C$ to $-55^\circ C$		1.8	10	$\mu V/^\circ C$
	$R_S = 10 k\Omega$ , $T_A = +25^\circ C$ to $+125^\circ C$		2.0	15	$\mu V/^\circ C$
	$R_S = 10 k\Omega$ , $T_A = +25^\circ C$ to $-55^\circ C$		4.8	25	$\mu V/^\circ C$
Input Offset Current	$T_A = +125^\circ C$		3.5	50	nA
	$T_A = -55^\circ C$		40	250	nA
Average Temperature Coefficient of Input Offset Current	$T_A = +25^\circ C$ to $T_A = +125^\circ C$		0.08	0.5	$nA/^\circ C$
	$T_A = +25^\circ C$ to $T_A = -55^\circ C$		0.45	2.8	$nA/^\circ C$
Input Bias Current	$T_A = -55^\circ C$		300	600	nA
Input Resistance	$T_A = -55^\circ C$	85	170		$k\Omega$
Input Voltage Range	$V_S = \pm 15 V$	$\pm 8.0$			V
Common Mode Rejection Ratio	$R_S \leq 10 k\Omega$	80	110		dB
Supply Voltage Rejection Ratio	$R_S \leq 10 k\Omega$		40	100	$\mu V/V$
Large-Signal Voltage Gain	$V_S = \pm 15 V$ , $R_L \geq 2 k\Omega$ , $V_{OUT} = \pm 15 V$	25,000		70,000	
Output Voltage Swing	$V_S = \pm 15 V$ , $R_L \geq 10 k\Omega$	$\pm 12$	$\pm 14$		V
	$V_S = \pm 15 V$ , $R_L \geq 2 k\Omega$	$\pm 10$	$\pm 13$		V
Supply Current	$T_A = +125^\circ C$ , $V_S = \pm 15 V$		2.1	3.0	mA
	$T_A = -55^\circ C$ , $V_S = \pm 15 V$		2.7	4.5	mA
Power Consumption	$T_A = +125^\circ C$ , $V_S = \pm 15 V$		63	90	mW
	$T_A = -55^\circ C$ , $V_S = \pm 15 V$		81	135	mW

GUARANTEED ELECTRICAL CHARACTERISTICS

(311 GRADE)



# FAIRCHILD LINEAR INTEGRATED CIRCUITS • $\mu$ A709

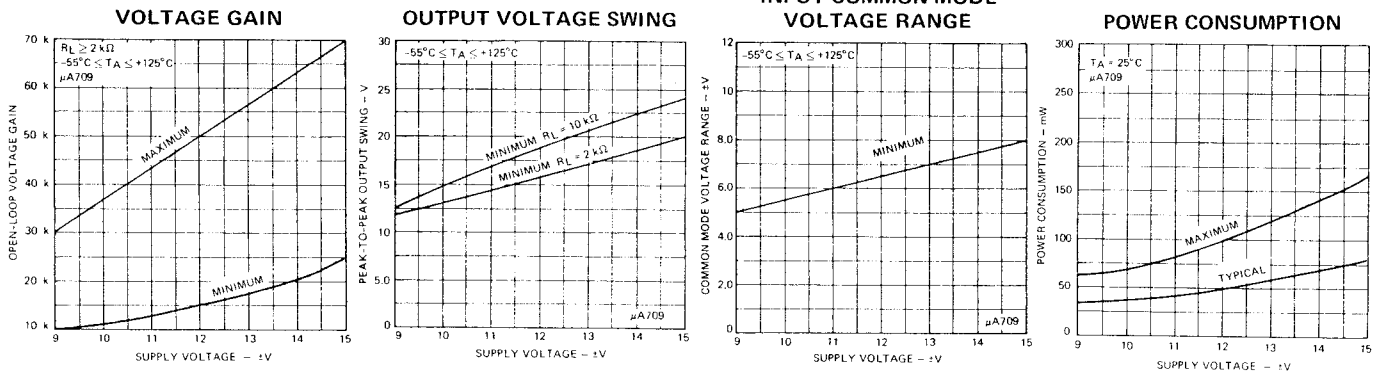
(312 GRADE)

ELECTRICAL CHARACTERISTICS ( $T_A = +25^\circ\text{C}$ ,  $\pm 9\text{ V} \leq V_S \leq \pm 15\text{ V}$  unless otherwise specified)

PARAMETER (see definitions)	CONDITIONS	MIN.	TYP.	MAX.	UNITS
Input Offset Voltage	$R_S \leq 10\text{ k}\Omega$		1.0	5.0	mV
Input Offset Current			50	200	nA
Input Bias Current			200	500	nA
Input Resistance		150	400		k $\Omega$
Output Resistance			150		$\Omega$
Power Consumption	$V_S = \pm 15\text{ V}$		80	165	mW
Transient Response	$V_{IN} = 20\text{ mV}$ , $R_L = 2\text{ k}\Omega$ ,				
Risetime	$C_1 = 5000\text{ pF}$ , $R_1 = 1.5\text{ k}\Omega$ , $C_2 = 200\text{ pF}$ , $R_2 = 50\Omega$		0.3	1.0	$\mu\text{s}$
Overshoot	$C_L \leq 100\text{ pF}$		10	30	%
The following specifications apply for $-55^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$ :					
Input Offset Voltage	$R_S \leq 10\text{ k}\Omega$			6.0	mV
Average Temperature Coefficient of Input Offset Voltage	$R_S = 50\Omega$ $R_S \leq 10\text{ k}\Omega$		3.0		$\mu\text{V}/^\circ\text{C}$ $\mu\text{V}/^\circ\text{C}$
Large-Signal Voltage Gain	$V_S = \pm 15\text{ V}$ , $R_L \geq 2\text{ k}\Omega$ , $V_{OUT} = \pm 10\text{ V}$	25,000	45,000	70,000	
Output Voltage Swing	$V_S = \pm 15\text{ V}$ , $R_L \geq 10\text{ k}\Omega$	$\pm 12$	$\pm 14$		V
	$V_S = \pm 15\text{ V}$ , $R_L \geq 2\text{ k}\Omega$	$\pm 10$	$\pm 13$		V
Input Voltage Range	$V_S = \pm 15\text{ V}$	$\pm 8.0$	$\pm 10$		V
Common Mode Rejection Ratio	$R_S \leq 10\text{ k}\Omega$	70	90		dB
Supply Voltage Rejection Ratio	$R_S \leq 10\text{ k}\Omega$		25	150	$\mu\text{V}/\text{V}$
Input Offset Current	$T_A = +125^\circ\text{C}$ $T_A = -55^\circ\text{C}$		20	200	nA
			100	500	nA
Input Bias Current	$T_A = -55^\circ\text{C}$		0.5	1.5	$\mu\text{A}$
Input Resistance		40	100		k $\Omega$

## GUARANTEED ELECTRICAL CHARACTERISTICS

(312 GRADE)



(393 GRADE)

ELECTRICAL CHARACTERISTICS ( $V_S = \pm 15\text{ V}$ ,  $T_A = 25^\circ\text{C}$  unless otherwise specified)

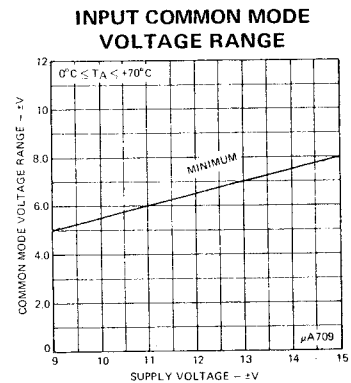
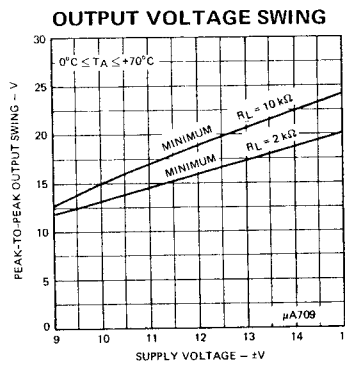
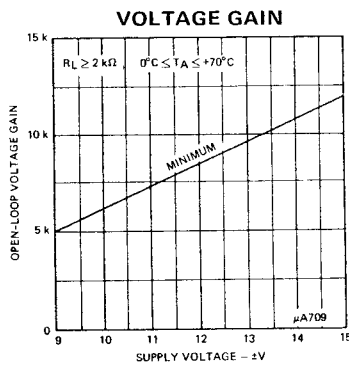
PARAMETER (see definitions)	CONDITIONS	MIN.	TYP.	MAX.	UNITS
Input Offset Voltage	$R_S \leq 10\text{ k}\Omega$ , $\pm 9\text{ V} \leq V_S \leq \pm 15\text{ V}$		2.0	7.5	mV
Input Offset Current			100	500	nA
Input Bias Current			0.3	1.5	$\mu\text{A}$
Input Resistance		50	250		$\text{k}\Omega$
Output Resistance			150		$\Omega$
Large-Signal Voltage Gain	$R_L \geq 2\text{ k}\Omega$ , $V_{OUT} = \pm 10\text{ V}$	15,000	45,000		
Output Voltage Swing	$R_L \geq 10\text{ k}\Omega$	$\pm 12$	$\pm 14$		V
	$R_L \geq 2\text{ k}\Omega$	$\pm 10$	$\pm 13$		V
Input Voltage Range		$\pm 8.0$	$\pm 10$		V
Common Mode Rejection Ratio	$R_S \leq 10\text{ k}\Omega$	65	90		dB
Supply Voltage Rejection Ratio	$R_S \leq 10\text{ k}\Omega$		25	200	$\mu\text{V/V}$
Power Consumption			80	200	mW
Transient Response					
Risetime	$V_{IN} = 20\text{ mV}$ , $R_L = 2\text{ k}\Omega$ , $C_1 = 5000\text{ pF}$ , $R_1 = 1.5\text{ k}\Omega$ , $C_2 = 200\text{ pF}$ , $R_2 = 50\Omega$		0.3		$\mu\text{s}$
Overshoot	$C_L \leq 100\text{ pF}$		10		%

The following specifications apply for  $0^\circ\text{C} \leq T_A \leq +70^\circ\text{C}$ :

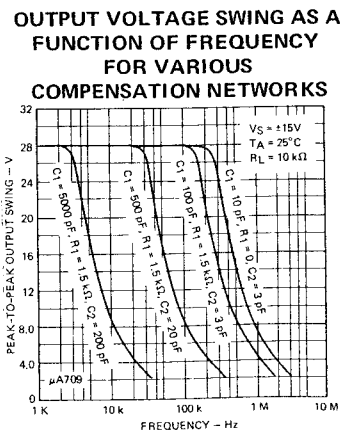
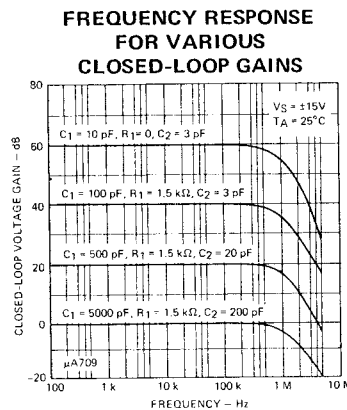
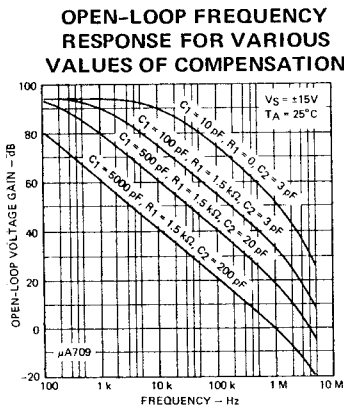
Input Offset Voltage	$R_S \leq 10\text{ k}\Omega$ , $\pm 9\text{ V} \leq V_S \leq \pm 15\text{ V}$			10	mV
Input Offset Current				750	nA
Input Bias Current				2.0	$\mu\text{A}$
Large-Signal Voltage Gain	$R_L \geq 2\text{ k}\Omega$ , $V_{OUT} = \pm 10\text{ V}$	12,000			
Input Resistance		35			$\text{k}\Omega$

GUARANTEED ELECTRICAL CHARACTERISTICS

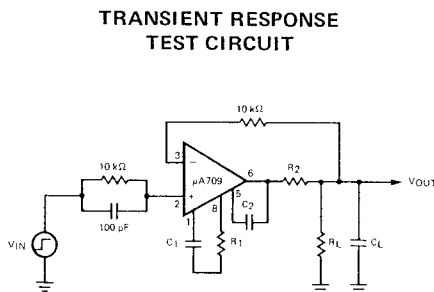
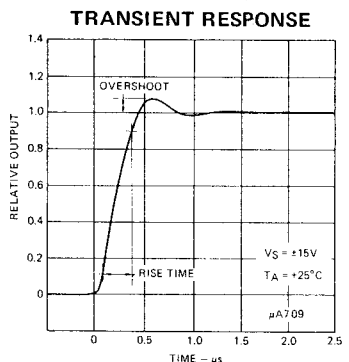
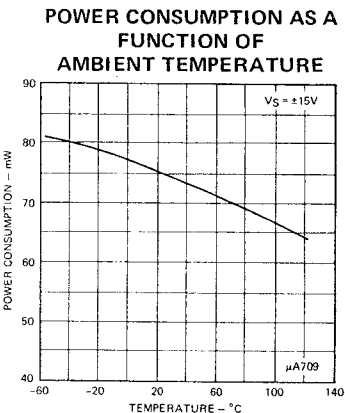
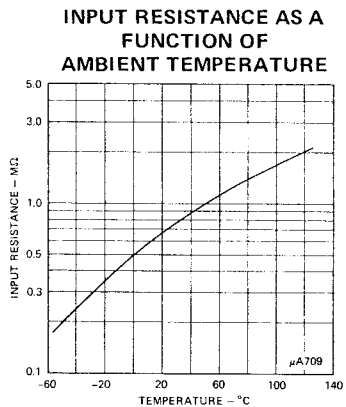
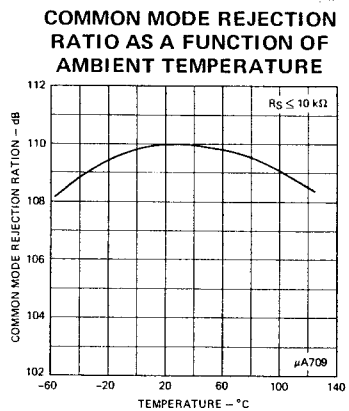
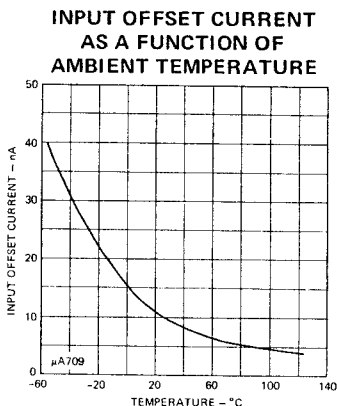
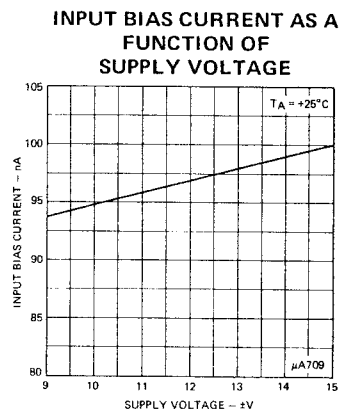
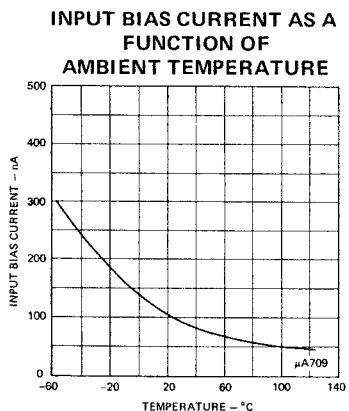
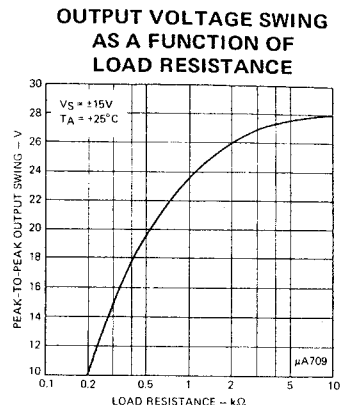
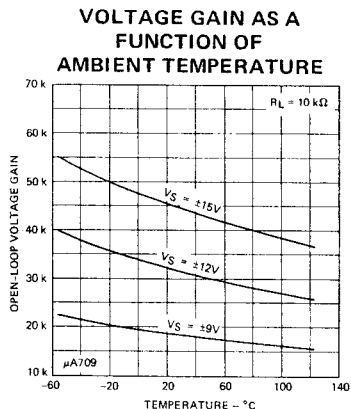
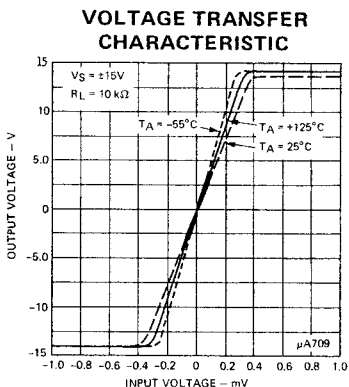
(393 GRADE)



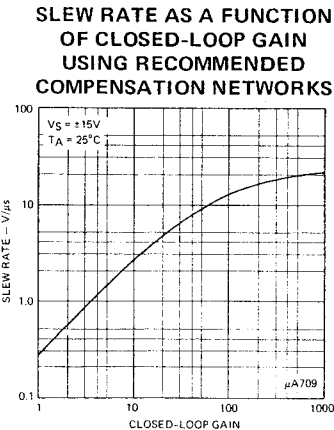
FREQUENCY COMPENSATION CURVES (FOR ALL GRADES)



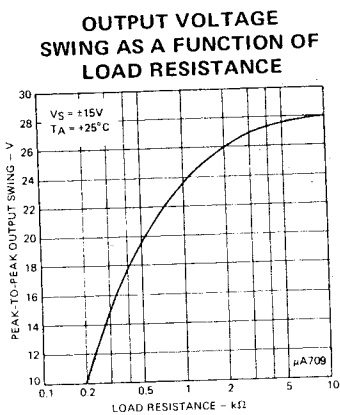
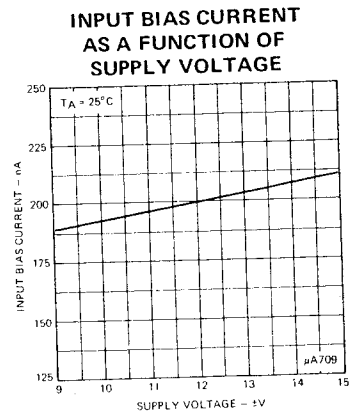
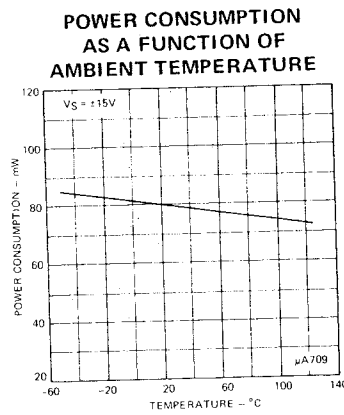
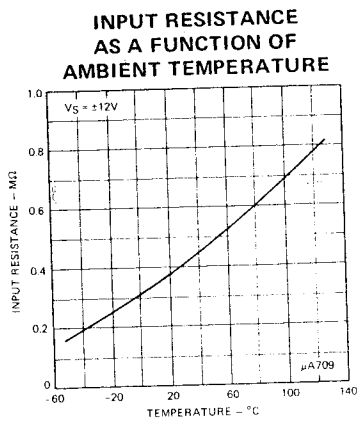
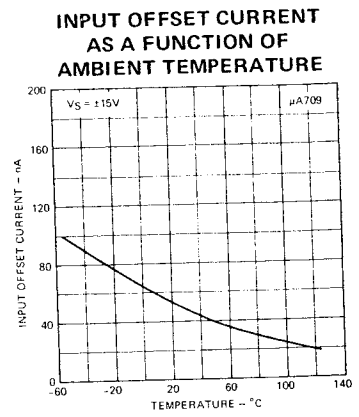
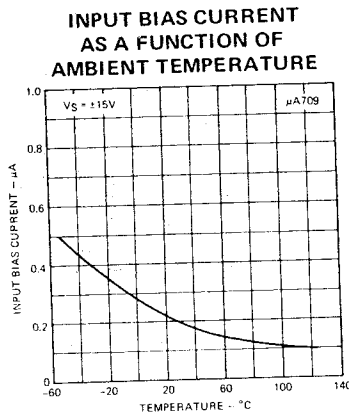
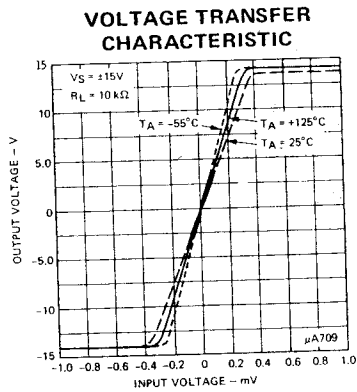
TYPICAL PERFORMANCE CURVES (FOR 311 GRADE)



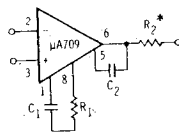
Pin numbers only apply to metal can package.



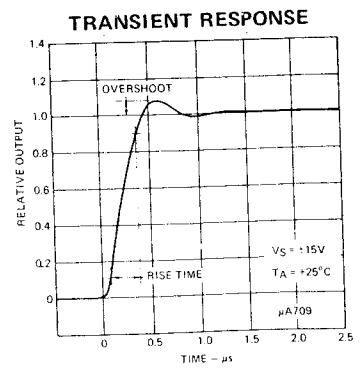
TYPICAL PERFORMANCE CURVES  
(FOR 312 AND 393 GRADES)



**FREQUENCY COMPENSATION CIRCUIT**

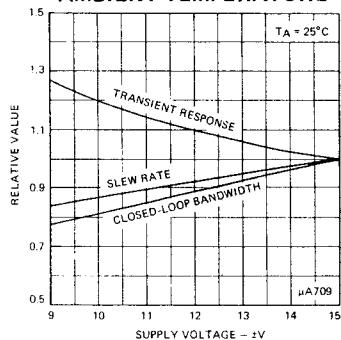


\* Use  $R_2 = 50 \Omega$  when the amplifier is operated with capacitive loading.

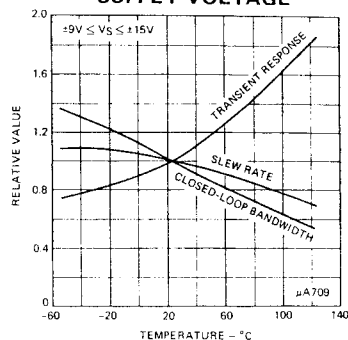


TYPICAL PERFORMANCE CURVES  
(FOR 312 AND 393 GRADES)

FREQUENCY CHARACTERISTICS  
AS A FUNCTION OF  
AMBIENT TEMPERATURE

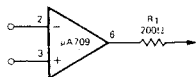


FREQUENCY CHARACTERISTICS  
AS A FUNCTION OF  
SUPPLY VOLTAGE

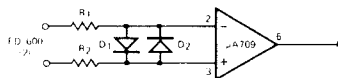


PROTECTION CIRCUITS

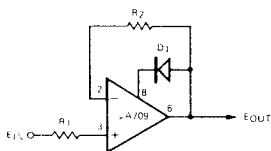
OUTPUT SHORT-CIRCUIT  
PROTECTION



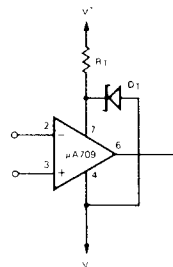
INPUT BREAKDOWN  
PROTECTION



LATCH-UP PROTECTION



SUPPLY OVERVOLTAGE  
PROTECTION



Pin numbers only apply to metal can package.