176079

μA709

HIGH-PERFORMANCE OPERATIONAL AMPLIFIER

FAIRCHILD LINEAR INTEGRATED CIRCUITS

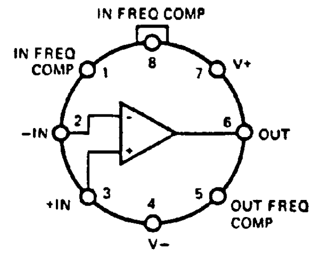
GENERAL DESCRIPTION — The μA709 is a monolithic High Gain Operational Amplifier constructed using the Fairchild Planar* epitaxial process. It features low offset, high input impedance, large input common mode range, high output swing under load and low power consumption. The device displays exceptional temperature stability and will operate over a wide range of supply voltages with little performance degradation. 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
Mini DIP	310 mW
DIP	670 mW
Flatpak	570 mW
Differential Input Voltage	±5.0 V
Input Voltage	±10 V
Storage Temperature Range	
Metal, Hermetic DIP, and Flatpak	−65°C to +150°C
Molded DIP and Mini DIP	−55°C to +125°C
Operating Temperature Range	
Military (μA709A and μA709)	−55°C to +125°C
Commercial (μA709C)	0°C to +70°C
Pin Temperature	
Metal Can, Hermetic DIP, and Flatpak (Soldering 60 s)	300°C
Molded DIP and Mini DIP	260°C
Output Short-Circuit Duration	5 s

NOTE:
Rating applies to ambient temperature up to 70°C. Above 70°C ambient derate linearly at 6.3mW/°C for Metal Can, 8.3mW/°C for DIP, 7.1mW/°C for the Flatpak and 5.6mW/°C for the Mini DIP.

CONNECTION DIAGRAMS
8-PIN METAL CAN
(TOP VIEW)
PACKAGE OUTLINE 5S
PACKAGE CODE H



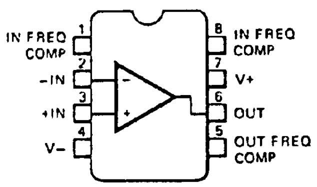
NOTE: Pin 4 connected to case

ORDER INFORMATION

TYPE	PART NO.
μA709A	μA709AHM
μA709	μA709HM
μA709C	μA709HC

CONNECTION DIAGRAMS

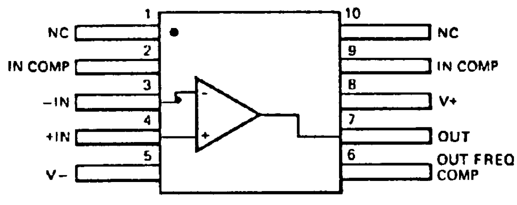
8-PIN MINI DIP
(TOP VIEW)
PACKAGE OUTLINE 9T
PACKAGE CODE T



ORDER INFORMATION

TYPE	PART NO.
μA709C	μA709TC

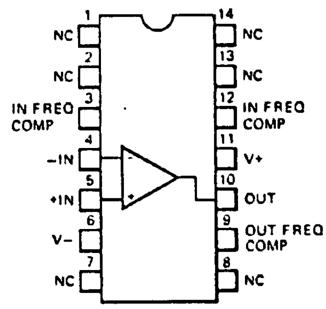
10-PIN FLATPAK
(TOP VIEW)
PACKAGE OUTLINE 3F
PACKAGE CODE F



ORDER INFORMATION

TYPE	PART NO.
μA709A	μA709AFM
μA709	μA709FM

14-PIN DIP
(TOP VIEW)
PACKAGE OUTLINE 6A 9A
PACKAGE CODE D P



ORDER INFORMATION

TYPE	PART NO.
μA709A	μA709ADM
μA709	μA709DM
μA709C	μA709DC
μA709C	μA709PC

*Planar is a patented Fairchild process

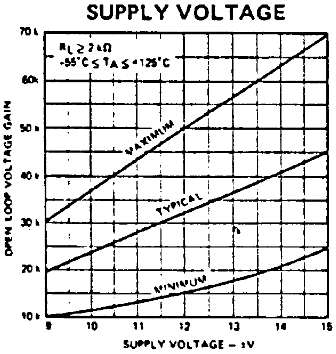
μA709A

ELECTRICAL CHARACTERISTICS: T_A = +25°C, ±9 V < V_S < ±15 V unless otherwise specified.

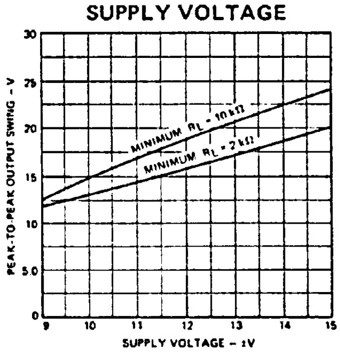
CHARACTERISTICS (see definitions)		CONDITIONS	MIN	TYP	MAX	UNITS
Input Offset Voltage		$R_S \leq 10$ kΩ		0.6	2.0	mV
Input Offset Current				10	50	nA
Input Bias Current				100	200	nA
Input Resistance			350	700		kΩ
Output Resistance				150		Ω
Supply Current		V_S = ±15 V		2.5	3.6	mA
Power Consumption		V_S = ±15 V		75	108	mW
Transient Response		V_S = ±15 V, V_{IN} = 20 mV, R_L = 2 kΩ, C1 = 5 nF, R1 = 1.5 kΩ, C2 = 200 pF, R2 = 50Ω			1.5	μs
	Overshoot	$C_L \leq 100$ pF			30	%
The following specifications apply for −55°C ≤ T_A ≤ +125°C:						
Input Offset Voltage		$R_S \leq 10$ kΩ			3.0	mV
Average Temperature Coefficient of Input Offset Voltage		R_S = 50Ω, T_A = +25°C to +125°C		1.8	10	μV/°C
		R_S = 50Ω, T_A = +25°C to −55°C		1.8	10	μV/°C
		R_S = 10 kΩ, T_A = +25°C to +125°C		2.0	15	μV/°C
		R_S = 10 kΩ, T_A = +25°C to −55°C		4.8	25	μV/°C
Input Offset Current		T_A = +125°C		3.5	50	nA
		T_A = −55°C		40	250	nA
Average Temperature Coefficient of Input Offset Current		T_A = +25°C to +125°C		0.08	0.5	nA/°C
		T_A = +25°C to −55°C		0.45	2.8	nA/°C
Input Bias Current		T_A = −55°C		300	600	nA
Input Resistance		T_A = −55°C	85	170		kΩ
Input Voltage Range		V_S = ±15 V	±8.0			V
Common Mode Rejection Ratio		$R_S \leq 10$ kΩ	80	110		dB
Supply Voltage Rejection Ratio		$R_S \leq 10$ kΩ		40	100	μV/V
Large Signal Voltage Gain		V_S = ±15 V, $R_L \geq 2$ kΩ, V_{OUT} = ±10 V	25,000		70,000	V/V
Output Voltage Swing		V_S = ±15 V, $R_L \geq 10$ kΩ	±12	±14		V
		V_S = ±15 V, $R_L \geq 2$ kΩ	±10	±13		V
Supply Current		T_A = +125°C, V_S = ±15 V		2.1	3.0	mA
		T_A = −55°C, V_S = ±15 V		2.7	4.5	mA
Power Consumption		T_A = +125°C, V_S = ±15 V		63	90	mW
		T_A = −55°C, V_S = ±15 V		81	135	mW

PERFORMANCE CURVES FOR μA709A

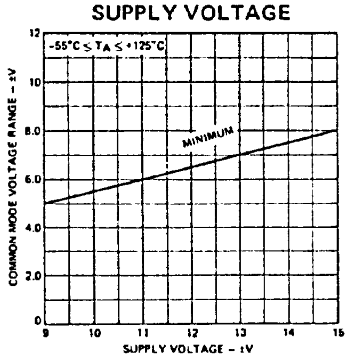
VOLTAGE GAIN AS A FUNCTION OF SUPPLY VOLTAGE



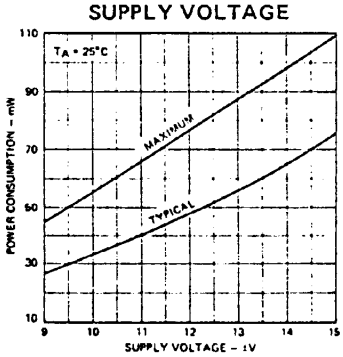
OUTPUT VOLTAGE SWING AS A FUNCTION OF SUPPLY VOLTAGE



INPUT COMMON MODE VOLTAGE RANGE AS A FUNCTION OF SUPPLY VOLTAGE



POWER CONSUMPTION AS A FUNCTION OF SUPPLY VOLTAGE



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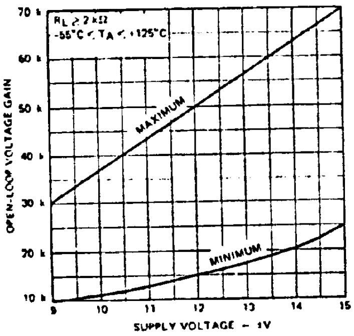
μA709

ELECTRICAL CHARACTERISTICS: T_A = +25°C, ±9 V < V_S < ±15 V unless otherwise specified.

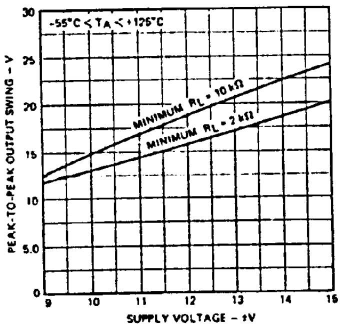
CHARACTERISTICS (see definitions)		CONDITIONS	MIN	TYP	MAX	UNITS
Input Offset Voltage		$R_S \le 10$ kΩ		1.0	5.0	mV
Input Offset Current				50	200	nA
Input Bias Current				200	500	nA
Input Resistance			150	400		kΩ
Output Resistance				150		Ω
Power Consumption		V_S = ±15 V		80	165	mW
Transient Response	Rise time	V_{IN} = 20 mV, R_L = 2 kΩ, C1 = 5000 pF, R1 = 1.5 kΩ, C2 = 200 pF, R2 = 50Ω		0.3	1.0	
	Overshoot	$C_L \le 100$ pF		10	30	%
The following specifications apply for −55°C ≤ T_A ≤ +125°C:						
Input Offset Voltage		$R_S \le 10$ kΩ			6.0	mV
Average Temperature Coefficient of Input Offset Voltage		R_S = 50Ω		3.0		μV/°C
		$R_S \le 10$ kΩ		6.0		μV/°C
Large Signal Voltage Gain		V_S = ±15 V, $R_L \ge 2$ kΩ, V_{OUT} = ±10 V	25,000	45,000	70,000	V/V
Output Voltage Swing		V_S = ±15 V, $R_L \ge 10$ kΩ	±12	±14		V
		V_S = ±15 V, $R_L \ge 2$ kΩ	±10	±13		V
Input Voltage Range		V_S = ±15 V	±8.0	±10		V
Common Mode Rejection Ratio		$R_S \le 10$ kΩ	70	90		dB
Supply Voltage Rejection Ratio		$R_S \le 10$ kΩ		25	150	μV/V
Input Offset Current		T_A = +125°C		20	200	nA
		T_A = −55°C		100	500	nA
Input Bias Current		T_A = −55°C		0.5	1.5	μA
Input Resistance			40	100		kΩ

PERFORMANCE CURVES FOR μA709

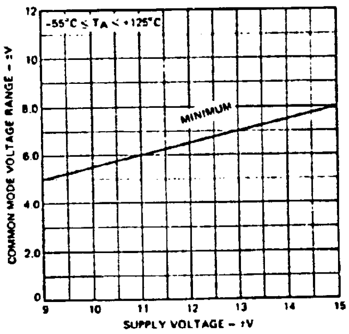
VOLTAGE GAIN AS A FUNCTION OF SUPPLY VOLTAGE



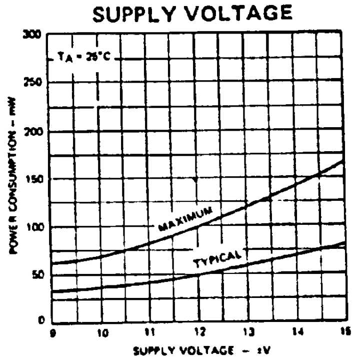
OUTPUT VOLTAGE SWING AS A FUNCTION OF SUPPLY VOLTAGE



INPUT COMMON MODE VOLTAGE RANGE AS A FUNCTION OF SUPPLY VOLTAGE



POWER CONSUMPTION AS A FUNCTION OF SUPPLY VOLTAGE



μA709C

ELECTRICAL CHARACTERISTICS: $V_S = \pm 15$ V, $T_A = 25°C$ unless otherwise specified.

CHARACTERISTICS (see definitions)		CONDITIONS	MIN	TYP	MAX	UNITS
Input Offset Voltage		$R_S \leq 10$ kΩ, ± 9 V $\leq V_S \leq \pm 15$ V		2.0	7.5	mV
Input Offset Current				100	500	nA
Input Bias Current				0.3	1.5	μA
Input Resistance			50	250		kΩ
Output Resistance				150		Ω
Large Signal Voltage Gain		$R_L \geq 2$ kΩ, $V_{OUT} = \pm 10$ V	15,000	45,000		V/V
Output Voltage Swing		$R_L \geq 10$ kΩ	±12	±14		V
		$R_L \geq 2$ kΩ	±10	±13		V
Input Voltage Range			±8.0	±10		V
Common Mode Rejection Ratio		$R_S \leq 10$ kΩ	65	90		dB
Supply Voltage Rejection Ratio		$R_S \leq 10$ kΩ		25	200	μV/V
Power Consumption				80	200	mW
Transient Response	Rise time	$V_{IN} = 20$ mV, $R_L = 2$ kΩ, C1 = 5000 pF, R1 = 1.5 kΩ,		0.3		μs
	Overshoot	C2 = 200 pF, R2 = 50Ω, $C_L \leq 100$ pF		10		%

The following specifications apply for $0°C \leq T_A \leq +70°C$:

CHARACTERISTICS	CONDITIONS	MIN	TYP	MAX	UNITS
Input Offset Voltage	$R_S \leq 10$ kΩ, ± 9 V $\leq V_S \leq \pm 15$ V			10	mV
Input Offset Current				750	nA
Input Bias Current				2.0	μA
Large Signal Voltage Gain	$R_L \geq 2$ kΩ, $V_{OUT} = \pm 10$ V	12,000			V/V
Input Resistance		35			kΩ

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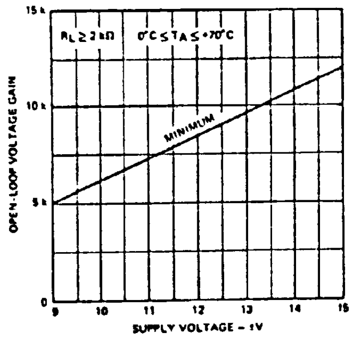
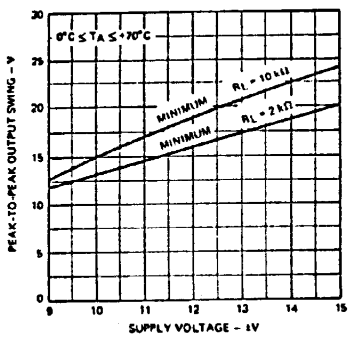
PERFORMANCE CURVES FOR μA709C

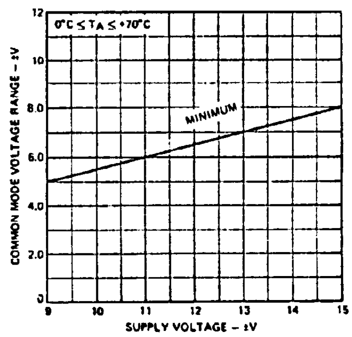
VOLTAGE GAIN AS A FUNCTION OF SUPPLY VOLTAGE



OUTPUT VOLTAGE SWING AS A FUNCTION OF SUPPLY VOLTAGE

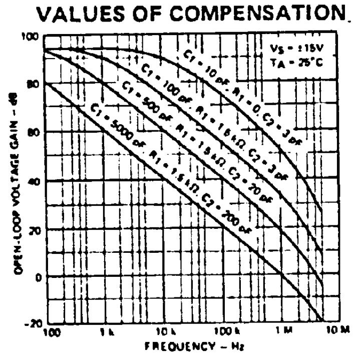


INPUT COMMON MODE VOLTAGE RANGE AS A FUNCTION OF SUPPLY VOLTAGE

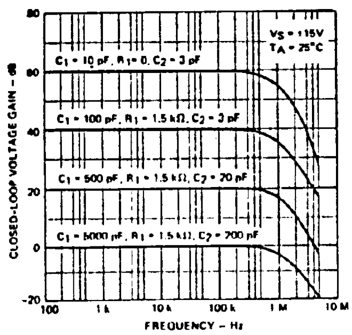


FREQUENCY COMPENSATION CURVES FOR ALL TYPES

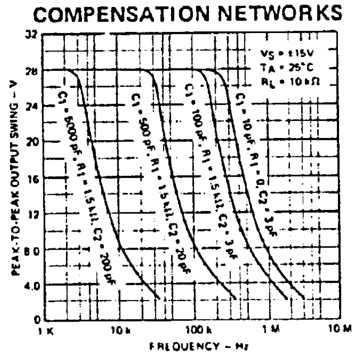
OPEN-LOOP FREQUENCY RESPONSE FOR VARIOUS VALUES OF COMPENSATION



FREQUENCY RESPONSE FOR VARIOUS CLOSED LOOP GAINS

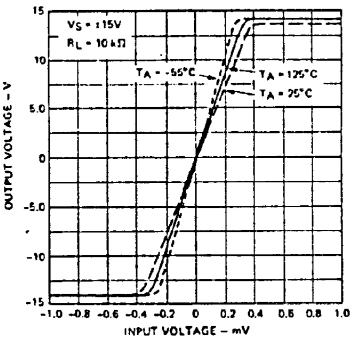


OUTPUT VOLTAGE SWING AS A FUNCTION OF FREQUENCY FOR VARIOUS COMPENSATION NETWORKS

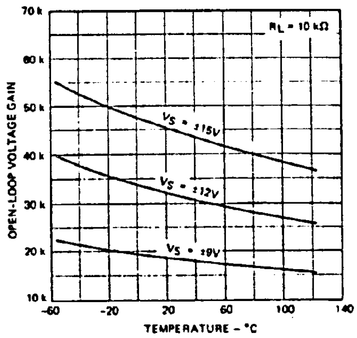


TYPICAL PERFORMANCE CURVES FOR μA709A

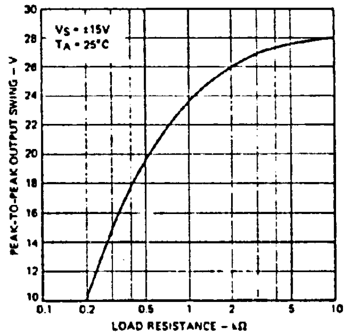
VOLTAGE TRANSFER CHARACTERISTIC



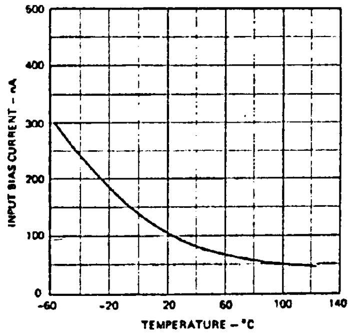
VOLTAGE GAIN AS A FUNCTION OF AMBIENT TEMPERATURE



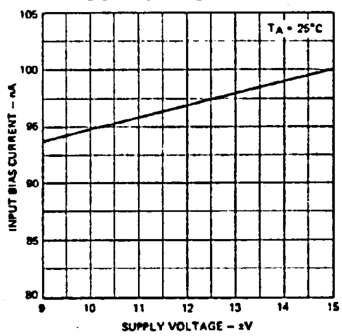
OUTPUT VOLTAGE SWING AS A FUNCTION OF LOAD RESISTANCE



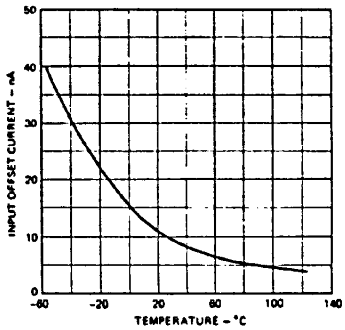
INPUT BIAS CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE



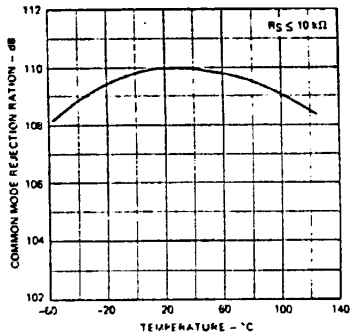
INPUT BIAS CURRENT AS A FUNCTION OF SUPPLY VOLTAGE



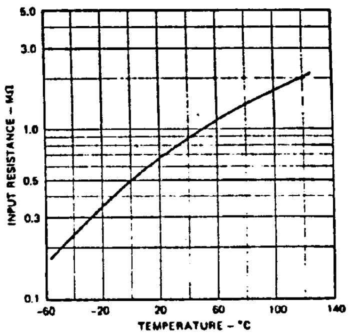
INPUT OFFSET CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE



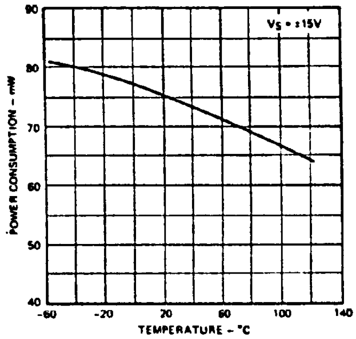
COMMON MODE REJECTION RATIO AS A FUNCTION OF AMBIENT TEMPERATURE



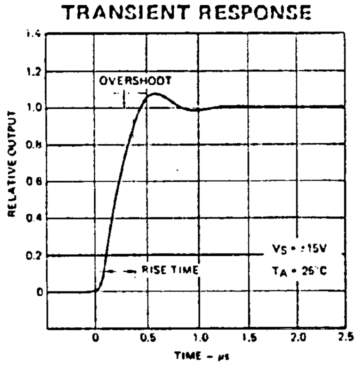
INPUT RESISTANCE AS A FUNCTION OF AMBIENT TEMPERATURE



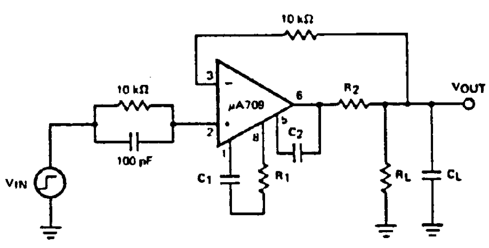
POWER CONSUMPTION AS A FUNCTION OF AMBIENT TEMPERATURE



TRANSIENT RESPONSE

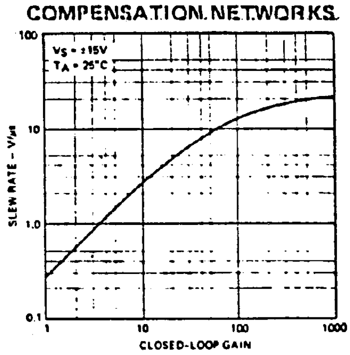


TRANSIENT RESPONSE TEST CIRCUIT



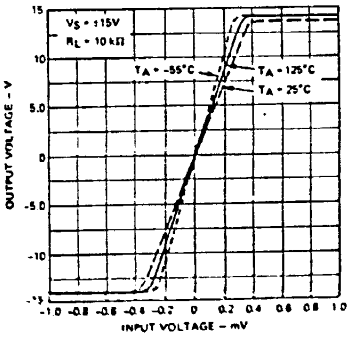
Pin numbers on this and all succeeding circuits apply to metal can or mini DIP package.

SLEW RATE AS A FUNCTION OF CLOSED-LOOP GAIN USING RECOMMENDED COMPENSATION NETWORKS

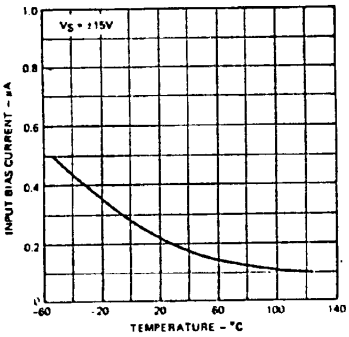


TYPICAL PERFORMANCE CURVES FOR μA709 AND μA709C

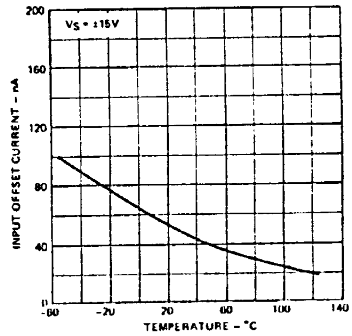
VOLTAGE TRANSFER CHARACTERISTIC



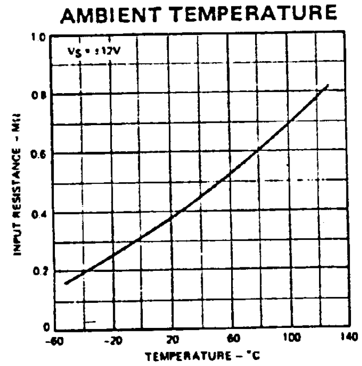
INPUT BIAS CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE



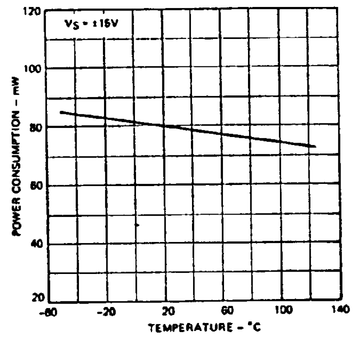
INPUT OFFSET CURRENT AS A FUNCTION OF AMBIENT TEMPERATURE



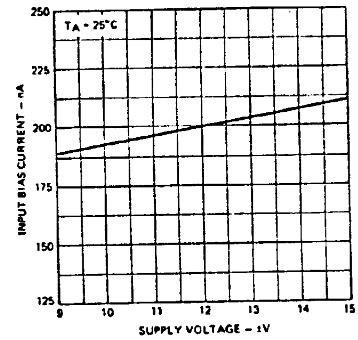
INPUT RESISTANCE AS A FUNCTION OF AMBIENT TEMPERATURE



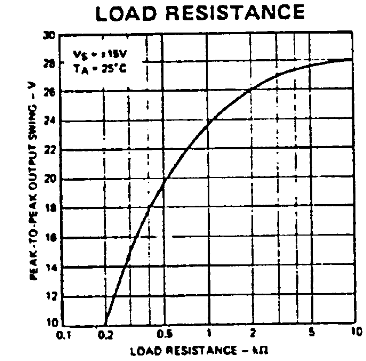
POWER CONSUMPTION AS A FUNCTION OF AMBIENT TEMPERATURE



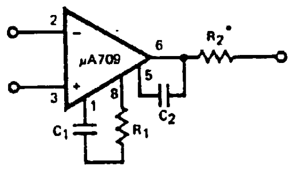
INPUT BIAS CURRENT AS A FUNCTION OF SUPPLY VOLTAGE



OUTPUT VOLTAGE SWING AS A FUNCTION OF LOAD RESISTANCE

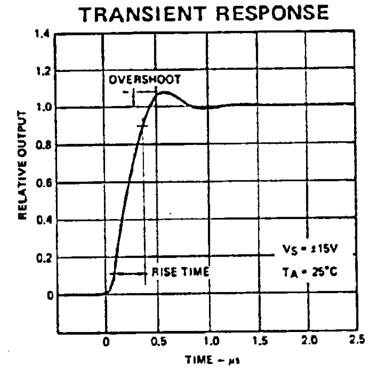


FREQUENCY COMPENSATION CIRCUIT

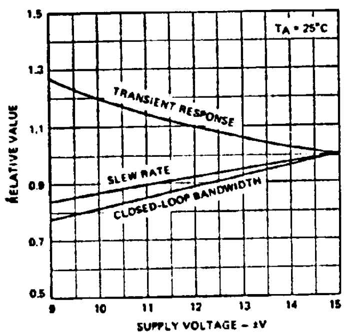


* Use R2 = 50 Ω when the amplifier is operated with capacitive loading.

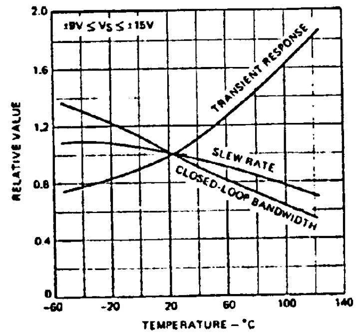
TRANSIENT RESPONSE



FREQUENCY CHARACTERISTICS AS A FUNCTION OF SUPPLY VOLTAGE

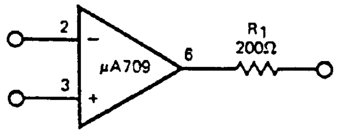


FREQUENCY CHARACTERISTICS AS A FUNCTION OF AMBIENT TEMPERATURE

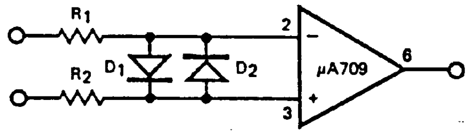


PROTECTION CIRCUITS

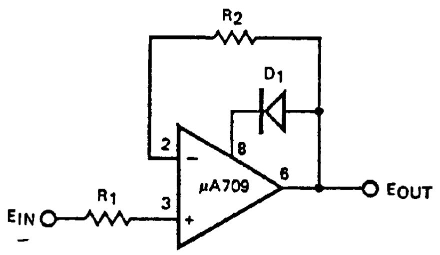
OUTPUT SHORT-CIRCUIT PROTECTION



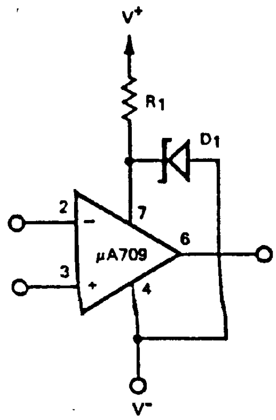
INPUT BREAKDOWN-PROTECTION



LATCH-UP PROTECTION



SUPPLY OVERVOLTAGE-PROTECTION



Pin numbers apply to metal can or mini DIP package only.

EQUIVALENT CIRCUIT