

# μA709C, μA709M, μA709AM GENERAL-PURPOSE OPERATIONAL AMPLIFIERS

SLOS096 – D942, FEBRUARY 1971 – REVISED MAY 1988

- **Common-Mode Input Range . . .  $\pm 10$  V Typical**
- **Designed to Be Interchangeable With Fairchild  $\mu$ A709A,  $\mu$ A709, and  $\mu$ A709C**
- **Maximum Peak-to-Peak Output Voltage Swing . . . 28-V Typical With 15-V Supplies**

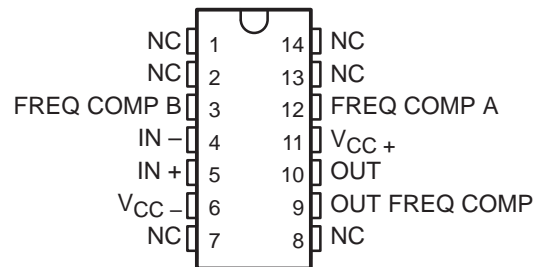
## description

These circuits are general-purpose operational amplifiers, each having high-impedance differential inputs and a low-impedance output. Component matching, inherent with silicon monolithic circuit-fabrication techniques, produces an amplifier with low-drift and low-offset characteristics. Provisions are incorporated within the circuit whereby external components may be used to compensate the amplifier for stable operation under various feedback or load conditions. These amplifiers are particularly useful for applications requiring transfer or generation of linear or nonlinear functions.

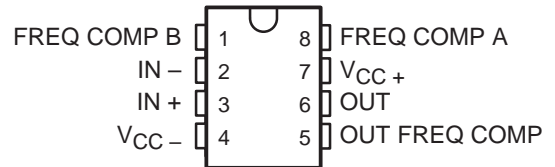
The  $\mu$ A709A circuit features improved offset characteristics, reduced input-current requirements, and lower power dissipation when compared to the  $\mu$ A709 circuit. In addition, maximum values of the average temperature coefficients of offset voltage and current are specified for the  $\mu$ A709A.

The  $\mu$ A709C is characterized for operation from 0°C to 70°C. The  $\mu$ A709AM and  $\mu$ A709M are characterized for operation over the full military temperature range of -55°C to 125°C.

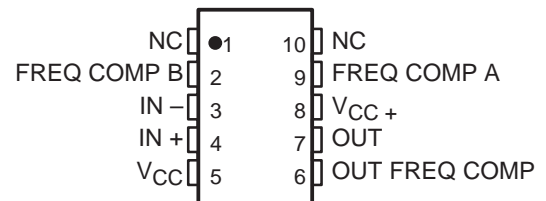
$\mu$ A709AM,  $\mu$ A709M . . . J OR W PACKAGE  
(TOP VIEW)



$\mu$ A709AM,  $\mu$ A709M . . . JG PACKAGE  
 $\mu$ A709C . . . D, JG, OR P PACKAGE  
(TOP VIEW)

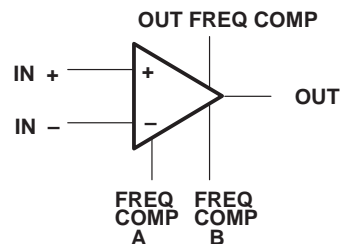


$\mu$ A709AM,  $\mu$ A709M . . . U FLAT PACKAGE  
(TOP VIEW)



NC – No internal connection

## symbol



## AVAILABLE OPTIONS

T <sub>A</sub>	V <sub>IO</sub> max AT 25°C	PACKAGE					
		SMALL OUTLINE (D)	CERAMIC (J)	CERAMIC DIP (JG)	PLASTIC DIP (P)	FLAT PACK (U)	FLAT PACK (W)
0°C to 70°C	7.5 mV	μA709CD	—	μA709CJG	μA709CP	—	—
-55°C to 125°C	5 mV 2 mV	—	μA709MJ μA709AMJ	μA709MJG μA709AMJG	—	μA709MU μA709AMU	μA709MW μA709AMW

The D package is available taped and reeled. Add the suffix R to the device type when ordering, (e.g.,  $\mu$ A709CDR).

PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

**TEXAS  
INSTRUMENTS**

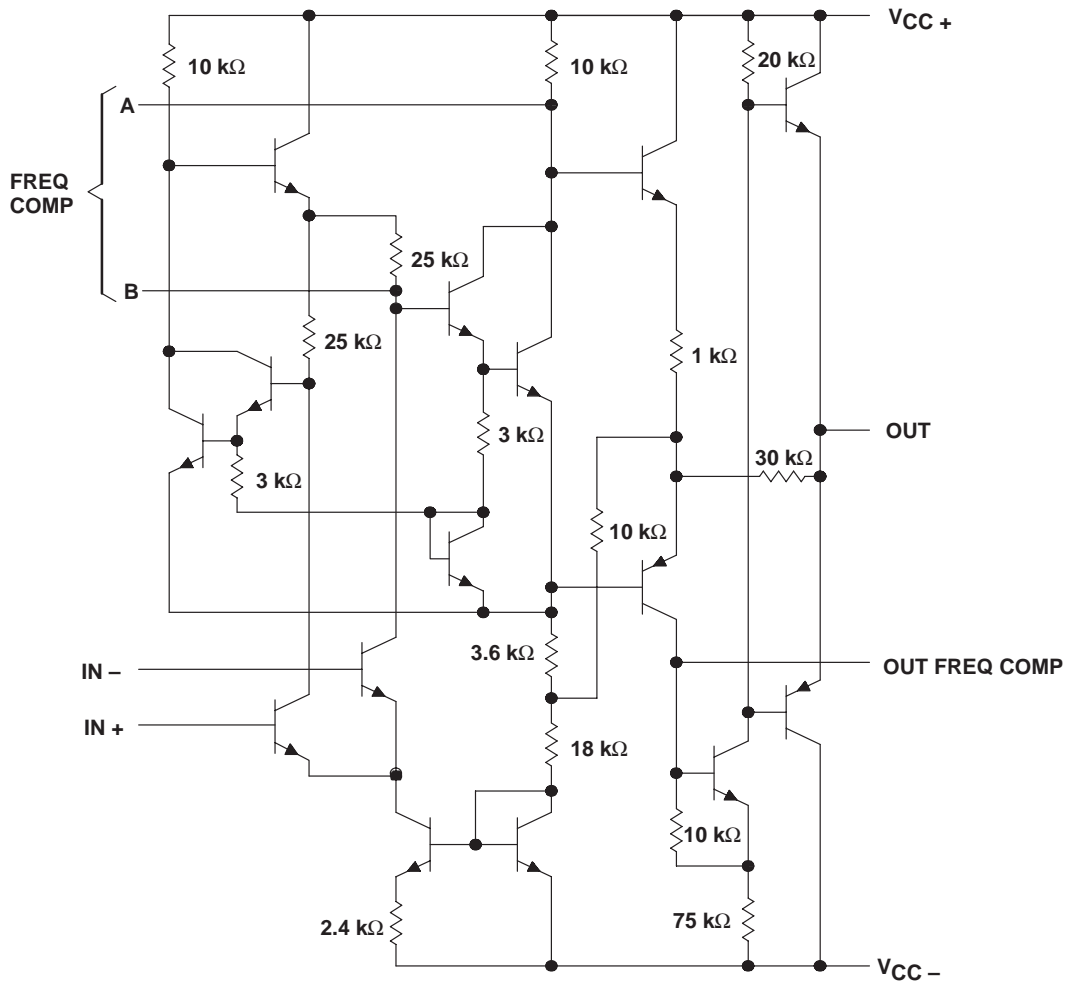
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## schematic



Component values shown are nominal.

## absolute maximum ratings over operating free-air temperature range (unless otherwise noted)

	uA709C	uA709M uA709AM	UNIT
Supply voltage, $V_{CC+}$ (see Note 1)	18	18	V
Supply voltage, $V_{CC-}$ (see Note 1)	-18	-18	V
Differential input voltage (see Note 2)	$\pm 5$	$\pm 5$	V
Input voltage (either input, see Notes 1 and 3)	$\pm 10$	$\pm 10$	V
Duration of output short circuit (see Note 4)	5	5	s
Continuous total power dissipation	See Dissipation Rating Table		
Operating free-air temperature range	0 to 70	-55 to 125	$^{\circ}\text{C}$
Storage temperature range	-65 to 150	-65 to 150	$^{\circ}\text{C}$
Lead temperature 1,6 mm (1/16 inch) from case for 60 seconds	J, JG, U, or W package		$^{\circ}\text{C}$
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds	D or P package		$^{\circ}\text{C}$

NOTES: 1. All voltage values, unless otherwise noted, are with respect to the midpoint between  $V_{CC+}$  and  $V_{CC-}$ .

2. Differential voltages are at the noninverting input terminal with respect to the inverting input terminal.

3. The magnitude of the input voltage must never exceed the magnitude of the supply voltage or 10 V, whichever is less.

4. The output may be shorted to ground or either power supply.



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DISSIPATION RATING TABLE

PACKAGE	$T_A \leq 25^\circ\text{C}$ POWER RATING	DERATING FACTOR	DERATE ABOVE $T_A$	$T_A = 70^\circ\text{C}$ POWER RATING	$T_A = 125^\circ\text{C}$ POWER RATING
D	300 mW	N/A	N/A	300 mW	N/A
J (uA709_M)	300 mW	11.0 mW/°C	123°C	300 mW	275 mW
JG (uA709_M)	300 mW	8.4 mW/°C	114°C	300 mW	210 mW
JG (uA709C)	300 mW	N/A	N/A	300 mW	N/A
P	300 mW	N/A	N/A	300 mW	N/A
U	300 mW	5.4 mW/°C	94°C	300 mW	135 mW
W	300 mW	8.0 mW/°C	113°C	300 mW	200 mW

# uA709M, uA709AM GENERAL-PURPOSE OPERATIONAL AMPLIFIERS

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electrical characteristics at specified free-air temperature,  $V_{CC} \pm = \pm 9\text{ V to } \pm 15\text{ V}$  (unless otherwise noted)

PARAMETER	TEST CONDITIONS†	T <sub>A</sub> ‡	uA709AMC			uA709M			UNIT
			MIN	TYP§	MAX	MIN	TYP§	MAX	
V <sub>IO</sub>	Input offset voltage	V <sub>O</sub> = 0, R <sub>S</sub> ≤ 10 kΩ	25°C	0.6	2	1	5	mV	
			Full range		3		6		
α <sub>VIO</sub>	Average temperature coefficient of input offset voltage	V <sub>O</sub> = 0, R <sub>S</sub> = 50 Ω	Full range	1.8	10	3	μV/°C		
			V <sub>O</sub> = 0, R <sub>S</sub> = 10 kΩ	Full range	4.8	25		6	
I <sub>IO</sub>	Input offset current	V <sub>O</sub> = 0	25°C	10	50	50	200	nA	
			-55°C	40	250	100	500		
			125°C	3.5	50	20	200		
α <sub>VIO</sub>	Average temperature coefficient of input offset voltage	V <sub>O</sub> = 0	-55°C to 25°C	0.45	2.8		nA/°C		
			25°C to 125°C	0.08	0.5				
I <sub>IB</sub>	Input bias current	V <sub>O</sub> = 0	25°C	0.1	0.2	0.2	0.5	μA	
			-55°C	0.3	0.6	0.5	1.5		
V <sub>ICR</sub>	Common-mode input voltage range	V <sub>CC</sub> ± = ±15 V	25°C	±8	±10	±8	±10	V	
			Full range	±8		±8			
V <sub>O(PP)</sub>	Maximum peak-to-peak output voltage swing	V <sub>CC</sub> ± = ±15 V, R <sub>L</sub> ≥ 10 kΩ	25°C	24	28	24	28	V	
			Full range	24		24			
		V <sub>CC</sub> ± = ±15 V, R <sub>L</sub> = 2 kΩ	25°C	20	26	20	26		
		V <sub>CC</sub> ± = ±15 V, R <sub>L</sub> ≥ 2 kΩ	Full range	20		20			
A <sub>VD</sub>	Large-signal differential voltage amplification	V <sub>CC</sub> ± = ±15 V, R <sub>L</sub> ≥ 2 kΩ, V <sub>O</sub> = ±10 V	25°C	45		45	V/mV		
			Full range	25	70	25		70	
r <sub>i</sub>	Input resistance		25°C	350	750	150	400	kΩ	
			-55°C	85	185	40	100		
r <sub>o</sub>	Output resistance	V <sub>O</sub> = 0, See Note 5	25°C	150		150	Ω		
CMRR	Common-mode rejection ratio	V <sub>IC</sub> = V <sub>ICRmin</sub>	25°C	80	110	70	90	dB	
			Full range	80		70			
k <sub>SVS</sub>	Power supply sensitivity (ΔV <sub>IO</sub> / ΔV <sub>CC</sub> )	V <sub>CC</sub> = ±9 V to ±15 V	25°C	40	100	25	150	μV/V	
			Full range		100		150		
I <sub>CC</sub>	Supply current	V <sub>CC</sub> ± = ±15 V, No load, V <sub>O</sub> = 0	25°C	2.5	3.6	2.6	5.5	mA	
			-55°C	2.7	4.5				
			125°C	2.1	3				
P <sub>D</sub>	Total power dissipation	V <sub>CC</sub> ± = ±15 V, No load, V <sub>O</sub> = 0	25°C	75	108	78	165	mW	
			-55°C	81	135				
			125°C	63	90				

† All characteristics are specified under open-loop with zero common-mode input voltage unless otherwise specified.

‡ Full range for uA709C is 0°C to 70°C. Full range for uA709AM and uA709M is -55°C to 125°C.

§ All typical values are at V<sub>CC</sub> ± = ±15 V.

NOTE 5: This typical value applies only at frequencies above a few hundred hertz because of the effects of drift and thermal feedback.



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**electrical characteristics at specified free-air temperature (unless otherwise noted  $V_{CC} \pm = \pm 15\text{ V}$ )**

PARAMETER	TEST CONDITIONS†	$T_A$ ‡	uA709C			UNIT
			MIN	TYP	MAX	
$V_{IO}$ Input offset voltage	$V_{CC\pm} = \pm 9\text{ V}$ to $\pm 15\text{ V}$ , $V_O = 0$	25°C		2	7.5	mV
		Full range			10	
$I_{IO}$ Input offset current	$V_{CC\pm} = \pm 9\text{ V}$ to $\pm 15\text{ V}$ , $V_O = 0$	25°C		100	500	nA
		Full range			750	
$I_{IB}$ Input bias current	$V_{CC\pm} = \pm 9\text{ V}$ to $\pm 15\text{ V}$ , $V_O = 0$	25°C		0.3	1.5	$\mu\text{A}$
		Full range			2	
$V_{ICR}$ Common-mode input voltage range		25°C	$\pm 8$	$\pm 10$		V
$V_{O(PP)}$ Maximum peak-to-peak output voltage swing	$R_L \geq 10\text{ k}\Omega$	25°C		24	28	V
		Full range		24		
		25°C		20	26	
$A_{VD}$ Large-signal differential voltage amplification	$R_L \leq 2\text{ k}\Omega$ , $V_O = \pm 10\text{ V}$	25°C		15	45	V/mV
		Full range		12		
$r_i$ Input resistance		25°C		50	250	$\text{k}\Omega$
		Full range		35		
$r_o$ Output resistance	$V_O = 0$ , See Note 5	25°C		150		$\Omega$
CMRR Common-mode rejection ratio	$V_{IC} = V_{ICR}$ min	25°C	65	90		dB
$k_{SVS}$ Supply voltage sensitivity	$V_{CC} = \pm 9\text{ V}$ to $\pm 15\text{ V}$	25°C		25	200	$\mu\text{V/V}$
$P_D$ Total power dissipation	$V_O = 0$ , No load	25°C		80	200	mW

† All characteristics are specified under open-loop operation with zero volts common-mode voltage unless otherwise specified.

‡ Full range for uA709C is 0°C to 70°C. Full range for uA709AM and uA709M is –55°C to 125°C.

NOTE 5: This typical value applies only at frequencies above a few hundred hertz because of the effects of drift and thermal feedback.

**operating characteristics,  $V_{CC} \pm = \pm 9\text{ V}$  to  $\pm 15\text{ V}$ ,  $T_A = 25^\circ\text{C}$**

PARAMETER	TEST CONDITIONS†	uA709C uA709M uA709AM			UNIT
		MIN	TYP	MAX	
$t_r$ Rise time	$V_I = 20\text{ mV}$ , $R_L = 2\text{ k}\Omega$ , See Figure 1		0.3	1	$\mu\text{s}$
Overshoot factor		$C_L = 100\text{ pF}$	6%	30%	

## PARAMETER MEASUREMENT INFORMATION

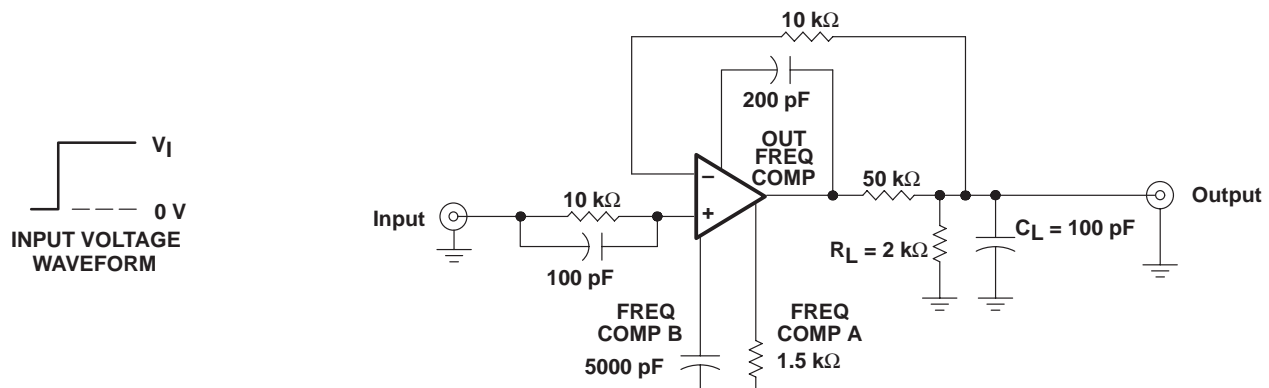


Figure 1. Rise Time and Slew Rate Test Circuit

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