MOTOROLA
SEMICONDUCTOR
TECHNICAL DATA

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MC1709
MC1709A
MC1709C

OPERATIONAL AMPLIFIER

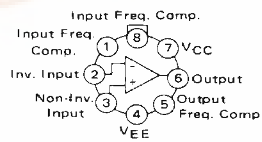
SILICON MONOLITHIC INTEGRATED CIRCUIT

MONOLITHIC OPERATIONAL AMPLIFIER

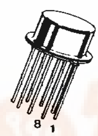
. . . designed for use as a summing amplifier, integrator, or amplifier with operating characteristics as a function of the external feedback components.

- High-Performance Open Loop Gain Characteristics A_{vol} = 45,000 typical
- Low Temperature Drift – ±3.0 µV/°C typical (MC1709)
- Large Output Voltage Swing – ±14 V typical @ ±15 V Supply
- Low Output Impedance – z_o = 150 ohms typical

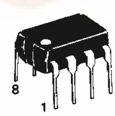
PIN CONNECTIONS



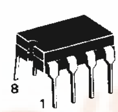
(Top View)



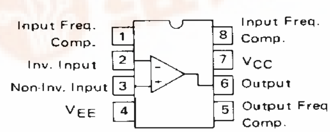
G SUFFIX
METAL PACKAGE
CASE 601



P1 SUFFIX
PLASTIC PACKAGE
CASE 626
(MC1709C Only)



U SUFFIX
CERAMIC PACKAGE
CASE 693

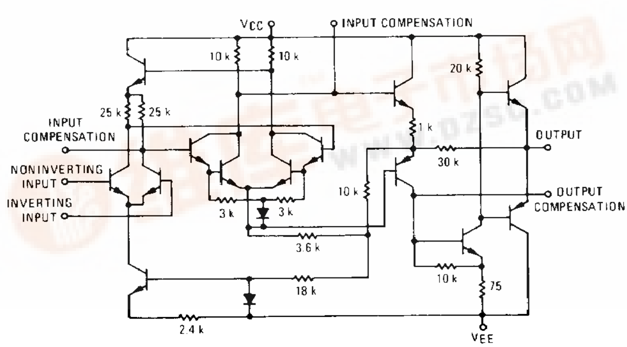


(Top View)

MAXIMUM RATINGS (T_A = +25°C unless otherwise noted.)

Rating	Symbol	Value	Unit
Power Supply Voltage	V_{CC} V_{EE}	+18 −18	Vdc
Input Differential Voltage Range	V_{IDR}	±5.0	Volts
Input Common-Mode Range	V_{ICR}	±10	Volts
Output Load Current	I_L	10	mA
Output Short-Circuit Duration	t_S	5.0	s
Power Dissipation (Package Limitation) Metal Can Derate above T_A = +25°C Plastic Dual In-Line Packages (MC1709C only) Derate above T_A = +25°C Ceramic Dual In-Line Package Derate above T_A = +25°C	P_D	 680 4.6 625 5.0 750 6.0	 mW mW/°C mW mW/°C mW/°C mW/°C
Operating Ambient Temperature Range MC1709A, MC1709 MC1709C	T_A	−55 to +125 0 to +70	°C
Storage Temperature Range Metal and Ceramic Packages Plastic Packages	T_{stg}	 −65 to +150 −55 to +125	°C

FIGURE 1 – EQUIVALENT CIRCUIT SCHEMATIC



ORDERING INFORMATION

Device	Temperature Range	Package
MC1709CG MC1709CU MC1709CP1	0°C to +70°C	Metal Can Ceramic DIP Plastic DIP
MC1709G,AG MC1709AU	−55°C to +125°C	Metal Can Ceramic DIP

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ELECTRICAL CHARACTERISTICS (unless otherwise noted, $+9.0\ V \leq V_{CC} \leq 15\ V$, $-9.0\ V \geq V_{EE} \geq -15\ V$, $T_A = 25°C$)

Characteristic	Symbol	MC1709A Min	MC1709A Typ	MC1709A Max	MC1709 Min	MC1709 Typ	MC1709 Max	Unit
Input Offset Voltage ($R_S \leq 10\ k\Omega$)	V_{IO}	–	0.6	2.0	–	1.0	5.0	mV
Input Offset Current	I_{IO}	–	10	50	–	50	200	nA
Input Bias Current	I_{IB}	–	100	200	–	200	500	nA
Input Resistance	r_i	350	700	–	150	400	–	kΩ
Output Resistance	r_o	–	150	–	–	150	–	Ω
Power Supply Currents (V_{CC} = 15 V, V_{EE} = -15 V)	I_{CC}, I_{EE}	–	2.5	3.6	–	–	–	mA
Power Consumption (V_{CC} = 15 V, V_{EE} = -15 V)	P_C	–	75	108	–	80	165	mW
Transient Response (V_{CC} = 15 V, V_{EE} = -15 V) See Figure 8								
Risetime	t_{TLH}	–	–	1.5	–	0.3	1.0	µs
Overshoot	OS	–	–	30	–	10	30	%

ELECTRICAL CHARACTERISTICS (unless otherwise noted, $+9.0\ V \leq V_{CC} \leq 15\ V$, $-9.0\ V \geq V_{EE} \geq -15\ V$, $T_A = -55°C$ to $+125°C$)

Characteristic	Symbol	MC1709A Min	MC1709A Typ	MC1709A Max	MC1709 Min	MC1709 Typ	MC1709 Max	Unit
Input Offset Voltage ($R_S \leq 10\ k\Omega$)	V_{IO}	–	–	3.0	–	–	6.0	mV
Average Temperature Coefficient of Input Offset Voltage	$\Delta V_{IO}/\Delta T$							µV/°C
(R_S = 50 Ω, T_A = 25°C to 125°C)		–	1.8	10	–	–	–	
(R_S = 50 Ω, T_A = -55°C to 25°C)		–	1.8	10	–	–	–	
(R_S = 50 Ω, T_A = -55°C to 125°C)		–	–	–	–	3.0	–	
(R_S = 10 kΩ, T_A = 25°C to 125°C)		–	2.0	15	–	–	–	
(R_S = 10 kΩ, T_A = -55°C to 25°C)		–	4.8	25	–	–	–	
(R_S = 10 kΩ, T_A = -55°C to 125°C)		–	–	–	–	6.0	–	
Input Offset Current	I_{IO}							nA
(T_A = -55°C)		–	40	250	–	100	500	
(T_A = 125°C)		–	3.5	50	–	20	200	
Average Temperature Coefficient of Input Offset Current	$\Delta I_{IO}/\Delta T$							nA/°C
(T_A = -55°C to 25°C)		–	0.45	2.8	–	–	–	
(T_A = 25°C to 125°C)		–	0.08	0.5	–	–	–	
Input Bias Current (T_A = -55°C)	I_{IB}	–	300	600	–	500	1500	nA
Input Resistance (T_A = -55°C)	r_i	85	170	–	40	100	–	kΩ
Input Common-Mode Voltage Range (V_{CC} = 15 V, V_{EE} = -15 V)	V_{ICR}	±8.0	±10	–	±8.0	±10	–	V
Common Mode Rejection Ratio ($R_S \leq 10$ kΩ)	CMRR	80	110	–	70	90	–	dB
Supply Voltage Rejection Ratio (V_{CC} = 15 V, V_{EE} = -15 V, $R_S \leq 10$ kΩ)	PSRR	–	40	100	–	25	150	µV/V
Large Signal Voltage Gain (V_{CC} = 15 V, V_{EE} = -15 V, $R_L \geq 2.0$ kΩ, V_O = ±15 V)	A_V	25	45	70	25	45	70	V/mV
Output Voltage Range (V_{CC} = 15 V, V_{EE} = -15 V)	V_{OR}							V
($R_L \geq 10$ kΩ)		±12	±14	–	±12	±14	–	
($R_L \geq 2.0$ kΩ)		±10	±13	–	±10	±13	–	
Power Supply Currents (V_{CC} = 15 V, V_{EE} = -15 V)	I_{CC}/I_{EE}							mA
(T_A = -55°C)		–	2.7	4.5	–	–	–	
(T_A = 125°C)		–	2.1	3.0	–	–	–	
Power Consumption (V_{CC} = 15, V_{EE} = -15 V)	P_C							mW
(T_A = -55°C)		–	81	135	–	–	–	
(T_A = 125°C)		–	63	90	–	–	–	

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ELECTRICAL CHARACTERISTICS (unless otherwise noted, V_{CC} = +15 V, V_{EE} = −15 V, T_A = 25°C)

Characteristic	Symbol	MC1709C Min	MC1709C Typ	MC1709C Max	Unit
Input Offset Voltage ($R_S \leq$ 10 kΩ, 9.0 V ≤ 15 V, -9.0 V ≥ V_{EE} ≥ -15 V)	V_{IO}	–	2.0	7.5	mV
Input Offset Current	I_{IO}	–	100	500	nA
Input Bias Current	I_{IB}	–	300	1500	nA
Input Resistance	r_i	50	250	–	kΩ
Output Resistance	r_o	–	150	–	Ω
Power Consumption	P_C	–	80	200	mW
Large Signal Voltage Gain ($R_L \geq$ 2.0 kΩ, V_O = ±10 V)	A_V	15	45	–	V/mV
Output Voltage Range	V_{OR}				V
($R_L \geq$ 10 kΩ)		±12	±14	–	
($R_L \geq$ 2.0 kΩ)		±10	±13	–	
Input Common-Mode Voltage Range	V_{ICR}	±8.0	±10	–	V
Common Mode Rejection Ratio ($R_S \leq$ 10 kΩ)	CMRR	65	90	–	dB
Supply Voltage Rejection Ratio ($R_S \leq$ 10 kΩ)	PSRR	–	25	200	μV/V
Transient Response See Figure 8					
Rise Time	t_{TLH}	–	0.3	–	μs
Overshoot	OS	–	10	–	%

ELECTRICAL CHARACTERISTICS (unless otherwise specified, V_{CC} = +15 V, V_{EE} = −15 V, T_A = 0°C to 70°C)

Parameter	Symbol	MC1709C Min	MC1709C Typ	MC1709C Max	Unit
Input Offset Voltage ($R_S \leq$ 10 kΩ, 9.0 V ≤ V_{CC} ≤ 15 V, -9.0 V ≥ V_{EE} ≥ 15 V)	V_{IO}	–	–	10	mV
Input Offset Current	I_{IO}	–	–	750	nA
Input Bias Current	I_{IB}	–	–	2.0	μA
Large Signal Voltage Gain ($R_L \geq$ 2.0 kΩ, V_O = ±10 V)	A_V	12	–	–	V/mV
Input Resistance	ri	35	–	–	kΩ

TYPICAL CHARACTERISTICS

FIGURE 2 – TEST CIRCUIT
(V_{CC} = +15 Vdc, V_{EE} = -15 Vdc, T_A = +25°C)

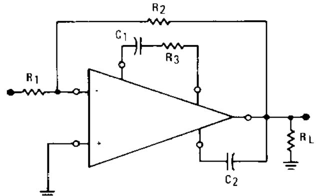

Fig. No.	Curve No.	Test Conditions R_1 (Ω)	R_2 (Ω)	R_3 (Ω)	C_1 (pF)	C_2 (pF)
3	1	10 k	10 k	1.5 k	5.0 k	200
	2	10 k	100 k	1.5 k	500	20
	3	10 k	1.0 M	1.5 k	100	3.0
	4	1.0 k	1.0 M	0	10	3.0
4	1	1.0 k	1.0 M	0	10	3.0
	2	10 k	1.0 M	1.5 k	100	3.0
	3	10 k	100 k	1.5 k	500	20
	4	10 k	10 k	1.5 k	5.0 k	200
5	1	0	∞	1.5 k	5.0 k	200
	2	0	∞	1.5 k	500	20
	3	0	∞	1.5 k	100	3.0
	4	0	∞	0	10	3.0

FIGURE 3 – LARGE SIGNAL SWING versus FREQUENCY

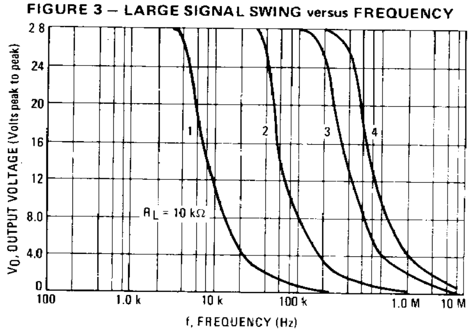

FIGURE 4 – CLOSED LOOP VOLTAGE GAIN versus FREQUENCY

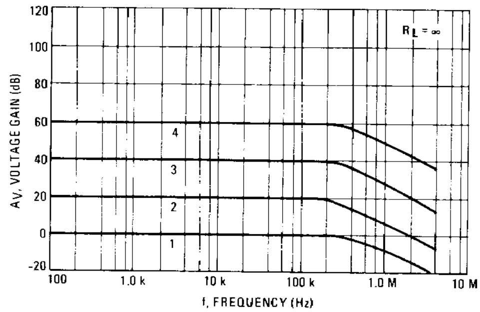

FIGURE 5 – OPEN LOOP VOLTAGE GAIN versus FREQUENCY

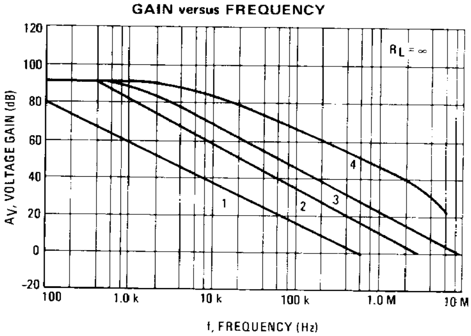

FIGURE 6 – VOLTAGE GAIN versus POWER SUPPLY VOLTAGE

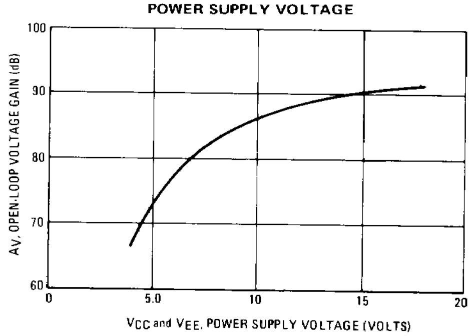

FIGURE 7 – SLEW RATE versus CLOSED LOOP GAIN USING RECOMMENDED COMPENSATION NETWORKS

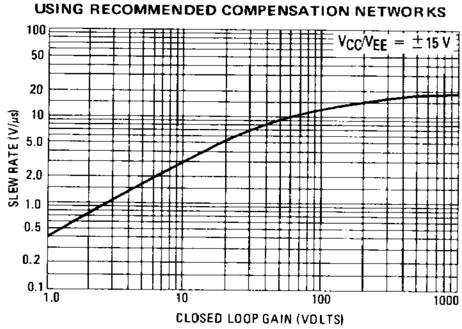

FIGURE 8 – TRANSIENT RESPONSE TEST CIRCUIT