LM124, LM224, LM224A, LM324, LM324A, LM2902
QUADRUPLE OPERATIONAL AMPLIFIERS

D1990, SEPTEMBER 1975—REVISED JANUARY 1989

T-79-10

- Wide Range of Supply Voltages:
  Single Supply . . . 3 V to 30 V
  (LM2902 . . . 3 V to 26 V),
  or Dual Supplies
- Low Supply Current Drain Independent of Supply Voltage . . . 0.8 mA Typ
- Common-Mode Input Voltage Range Includes Ground Allowing Direct Sensing near Ground
- Low Input Bias and Offset Parameters:
  Input Offset Voltage . . . 3 mV Typ
  A Versions . . . 2 mV Typ
  Input Offset Current . . . 2 nA Typ
  Input Bias Current . . . 20 nA Typ
  A Versions . . . 15 nA Typ
- Differential Input Voltage Range Equal to Maximum-Rated Supply Voltage . . . 32 V (26 V for LM2902)
- Open-Loop Differential Voltage Amplification . . . 100 V/mV Typ
- Internal Frequency Compensation

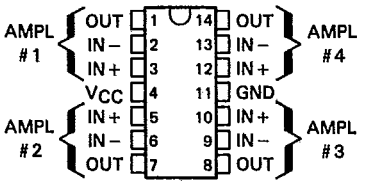
description

These devices consist of four independent, high-gain frequency-compensated operational amplifiers that were designed specifically to operate from a single supply over a wide range of voltages. Operation from split supplies is also possible so long as the difference between the two supplies is 3 V to 30 V (for the LM2902, 3 V to 26 V), and Pin 4 is at least 1.5 V more positive than the input common-mode voltage. The low supply current drain is independent of the magnitude of the supply voltage.

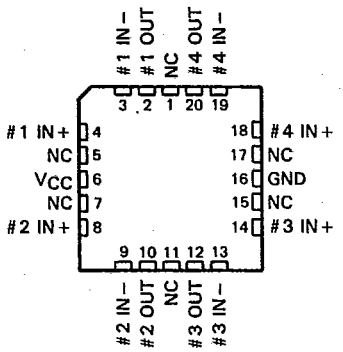
Applications include transducer amplifiers, d-c amplification blocks, and all the conventional operational amplifier circuits that now can be more easily implemented in single-supply-voltage systems. For example, the LM124 can be operated directly off of the standard 5-V supply that is used in digital systems and will easily provide the required interface electronics without requiring additional ±15-V supplies.

The LM124 is characterized for operation over the full military temperature range of −55°C to 125°C. The LM2902 is characterized for operation from −40°C to 105°C, the LM224 and LM224A from −25°C to 85°C, and the LM324 and LM324A from 0°C to 70°C.

LM124 . . . J OR W PACKAGE
ALL OTHERS . . . D, J, OR N PACKAGES
(TOP VIEW)

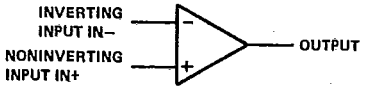


LM124
FK CHIP CARRIER PACKAGE
(TOP VIEW)



NC—No internal connection

symbol (each amplifier)



2 Operational Amplifiers

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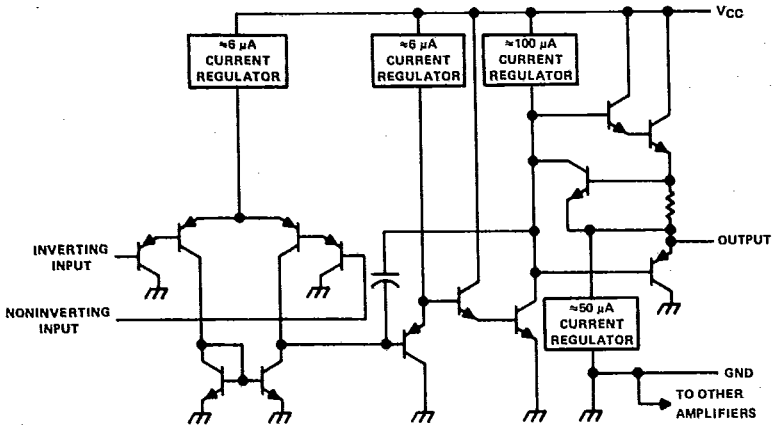
LM124, LM224, LM224A, LM324, LM324A, LM2902 QUADRUPLE OPERATIONAL AMPLIFIERS

AVAILABLE OPTIONS

T_A	V_{IO} MAX AT 25°C	PACKAGE				
		SMALL OUTLINE (D)	CHIP CARRIER (FK)	CERAMIC DIP (J)	PLASTIC DIP (N)	FLAT PACK (W)
0°C to 70°C	7 mV	LM324D	—	LM324J	LM324N	—
	3 mV	LM324AD		LM324AJ	LM324AN	
−25°C to 85°C	5 mV	LM224D	—	LM224J	LM224N	—
	3 mV	LM224AD		LM224AJ	LM224AN	
−40°C to 105°C	7 mV	LM2902D	—	LM2902J	LM2902N	—
−55°C to 125°C	5 mV	—	LM124FK	LM124J	—	LM124W

The D package is available taped and reeled. Add the suffix R to the device type when ordering. (e.g., LM324DR)

schematic (each amplifier)



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

			LM124, LM224, LM224A, LM324, LM324A	LM2902	UNIT
Supply voltage, V_{CC} (see Note 1)			32	26	V
Differential voltage (see Note 2)			±32	±26	V
Input voltage range (either input)			−0.3 to 32	−0.3 to 26	V
Duration of output short-circuit (one amplifier) to ground at (or below) 25°C free-air temperature (V_{CC} ≤ 15 V) (see Note 3)			unlimited	unlimited	
Continuous total dissipation			See Dissipation Rating Table		
Operating free-air temperature range	LM124		−55 to 125		°C
	LM224, LM224A		−25 to 85		
	LM324, LM324A		0 to 70		
	LM2902			−40 to 105	
Storage temperature range			−65 to 150	−65 to 150	°C
Case temperature for 60 seconds		FK package	260		°C
Lead temperature 1,6 mm (1/16 inch) from case for 60 seconds		J or W package	300	300	°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds		D or N package	260	260	°C

NOTES: 1. All voltage values, except differential voltages and V_{CC} specified for the measurement of I_{OS}, are with respect to the network ground terminal.
2. Differential voltages are at the noninverting input terminal with respect to the inverting input terminal.
3. Short circuits from outputs to V_{CC} can cause excessive heating and eventual destruction.

DISSIPATION RATING TABLE

PACKAGE	T_A ≤ 25°C POWER RATING	DERATING FACTOR	DERATE ABOVE T_A	T_A = 70°C POWER RATING	T_A = 85°C POWER RATING	T_A = 125°C POWER RATING
D	900 mW	7.6 mW/°C	32°C	608 mW	494 mW	N/A
FK	900 mW	11.0 mW/°C	68°C	880 mW	715 mW	275 mW
J (LM124)	900 mW	11.0 mW/°C	68°C	880 mW	715 mW	275 mW
J (all others)	900 mW	8.2 mW/°C	40°C	656 mW	533 mW	N/A
N	900 mW	9.2 mW/°C	52°C	736 mW	598 mW	N/A
W	900 mW	8.0 mW/°C	37°C	640 mW	520 mW	200 mW

electrical characteristics at specified free-air temperature, V_{CC} = 5 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS†		LM124, LM224			LM324			LM2902			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO}	Input offset voltage	V_{CC} = 5 V to MAX, $V_{IC} = V_{ICR}$ min, V_O = 1.4 V	25°C		3	5		3	7		3	7	mV
			Full range			7			9			10	
I_{IO}	Input offset current	V_O = 1.4 V	25°C		2	30		2	50		2	50	nA
			Full range			100			150			200	
I_{IB}	Input bias current	V_O = 1.4 V	25°C		−20	−150		−20	−250		−20	−250	nA
			Full range			−300			−500			−500	
V_{ICR}	Common-mode input voltage range	V_{CC} = 5 V to MAX	25°C	0 to V_{CC}−1.5			0 to V_{CC}−1.5			0 to V_{CC}−1.5			V
			Full range	0 to V_{CC}−2			0 to V_{CC}−2			0 to V_{CC}−2			
V_{OH}	High-level output voltage	R_L = 2 kΩ	25°C	V_{CC}−1.5			V_{CC}−1.5						V
		R_L = 10 kΩ	25°C							V_{CC}−1.5			
		V_{CC} = MAX, R_L = 2 kΩ	Full range	26			26			22			
		V_{CC} = MAX, R_L = 10 kΩ	Full range	27	28		27	28		23	24		
V_{OL}	Low-level output voltage	$R_L \le$ 10 kΩ	Full range		5	20		5	20		5	100	mV
A_{VD}	Large-signal differential voltage amplification	V_{CC} = 15 V, V_O = 1 V to 11 V, $R_L \ge$ 2 kΩ	25°C	50	100		25	100			100		V/mV
			Full range	25			15			15			
CMRR	Common-mode rejection ratio	$V_{IC} = V_{ICR}$ min	25°C	70	80		65	80		50	80		dB
k_{SVR}	Supply voltage rejection ratio ($\Delta V_{CC}/\Delta V_{IO}$)		25°C	65	100		65	100		50	100		dB
V_{O1}/V_{O2}	Crosstalk attenuation	f = 1 kHz to 20 kHz	25°C		120			120			120		dB
I_O	Output current	V_{CC} = 15 V, V_{ID} = 1 V, V_O = 0	25°C	−20	−30	−60	−20	−30	−60	−20	−30	−60	mA
			Full range	−10			−10			−10			
		V_{CC} = 15 V, V_{ID} = −1 V, V_O = 15 V	25°C	10	20		10	20		10	20		
			Full range	5			5			5			
		V_{ID} = −1 V, V_O = 200 mV	25°C	12	30		12	30			30		μA
I_{OS}	Short-circuit output current	V_{CC} at 5 V, GND at −5 V, V_O = 0	25°C		±40	±60		±40	±60		±40	±60	mA
I_{CC}	Supply current (four amplifiers)	V_O = 2.5 V, No load	Full range		0.7	1.2		0.7	1.2		0.7	1.2	mA
		V_{CC} = MAX, V_O = 0.5 V_{CC}, No load	Full range		1.1	3		1.1	3		1.1	3	

†All characteristics are measured under open-loop conditions with zero common-mode input voltage unless otherwise specified. "MAX" V_{CC} for testing purposes is 26 V for LM2902, 30 V for the others. Full range is −55°C to 125°C for LM124, −25°C to 85°C for LM224, 0°C to 70°C for LM324, and −40°C to 105°C for LM2902.

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electrical characteristics at specified free-air temperature, V_{CC} = 5 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS†		LM224A			LM324A			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
V_{IO}	Input offset voltage	V_{CC} = 5 V to 30 V, V_{IC} = V_{ICR} min, V_O = 1.4 V	25°C		2	3		2	3	mV
			Full range			4			5	
I_O	Input offset current	V_O = 1.4 V	25°C		2	15		2	30	nA
			Full range			30			75	
I_{IB}	Input bias current	V_O = 1.4 V	25°C		−15	−80		−15	−100	nA
			Full range			−100			−200	
V_{ICR}	Common-mode input voltage range	V_{CC} = 30 V	25°C	0 to V_{CC}−1.5			to V_{CC}−1.5			V
			Full range	0 to V_{CC}−2			0 to V_{CC}−2			
V_{OH}	High-level output voltage	R_L = 2 kΩ	25°C	V_{CC}−1			V_{CC}−1			V
		V_{CC} 30 V, R_L = 2 kΩ	Full range	26			26			
		V_{CC} = 30 V, R_L = 10 kΩ	Full range	27	28		27	28		
V_{OL}	Low-level output voltage	R_I ≤ 10 kΩ	Full range		5	20		5	20	mV
A_{VD}	Large-signal differential voltage amplification	V_{CC} = 15 V, V_O = 1 V to 11 V, R_L ≥ 2 kΩ	25°C	50	100		25	100		V/mV
			Full range	25			15			
CMRR	Common-mode rejection ratio	V_{IC} = V_{ICR} min	25°C	70	80		65	80		dB
k_{SVR}	Supply voltage rejection ratio ($\Delta V_{CC}/\Delta V_{IO}$)		25°C	65	100		65	100		dB
V_{o1}/V_{o2}	Crosstalk attenuation	f = 1 kHz to 20 kHz	25°C		120			120		dB
I_O	Output current	V_{CC} = 15 V, V_{ID} = 1 V, V_O = 0	25°C	−20	−30	−60	−20	−30	−60	mA
			Full range	−10			−10			
		V_{CC} = 15 V, V_{ID} = −1 V, V_O = 15 V	25°C	10	20		10	20		
			Full range	5			5			
		V_{ID} = −1 V, V_O = 200 mV	Full range	12	30		12	30		μA
I_{OS}	Short-circuit output current	V_{CC} at 5 V, GND at −5 V, V_O = 0	25°C		±40	±60		±40	±60	mA
I_{CC}	Supply current (four amplifiers)	V_O = 2.5 V, No load	Full range		1.5	2.4		1.5	2.4	mA
		V_{CC} = 30 V, V_O = 15 V, No load	Full range		1.1	3		1.1	3	

†All characteristics are measured under open-loop conditions with zero common-mode input voltage unless otherwise specified. Full range is −25°C to 85°C for LM224A and 0°C to 70°C for LM324A.

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