

LM124, LM124A, LM224, LM224A LM324, LM324A, LM324Y, LM2902, LM2902Q QUADRUPLE OPERATIONAL AMPLIFIERS

SLOS066B – SEPTEMBER 1975 – REVISED MARCH 1994

- **Wide Range of Supply Voltages:**
Single Supply . . . 3 V to 30 V (LM2902 and LM2902Q 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 and LM2902Q)**
- **Open-Loop Differential Voltage Amplification . . . 100 V/mV Typ**
- **Internal Frequency Compensation**

description

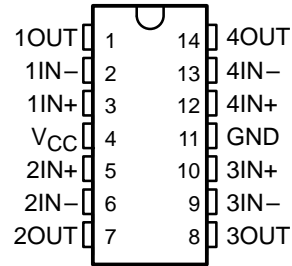
These devices consist of four independent high-gain frequency-compensated operational amplifiers that are designed specifically to operate from a single supply over a wide range of voltages. Operation from split supplies is also possible when the difference between the two supplies is 3 V to 30 V (for the LM2902 and LM2902Q, 3 V to 26 V) and V_{CC} 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, dc 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 from the standard 5-V supply that is used in digital systems and easily provides the required interface electronics without requiring additional ± 15 -V supplies.

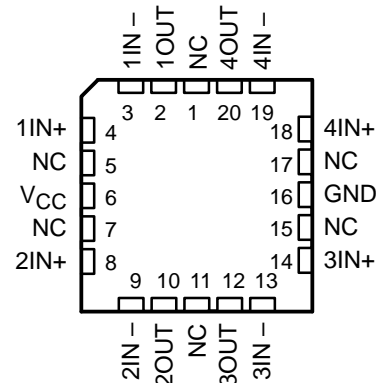
The LM2902Q is manufactured to demanding automotive requirements.

The LM124 and LM124A are characterized for operation over the full military temperature range of -55°C to 125°C . The LM224 and LM224A are characterized for operation from -25°C to 85°C . The LM324 and LM324A are characterized for operation from 0°C to 70°C . The LM2902 and LM2902Q are characterized for operation from -40°C to 105°C .

LM124, LM224A . . . J OR W PACKAGE
ALL OTHERS . . . D, DB, J, N OR PW PACKAGE
(TOP VIEW)

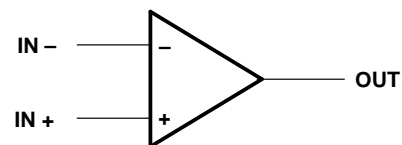


LM124, LM124A . . . FK PACKAGE
(TOP VIEW)



NC – No internal connection

symbol (each amplifier)



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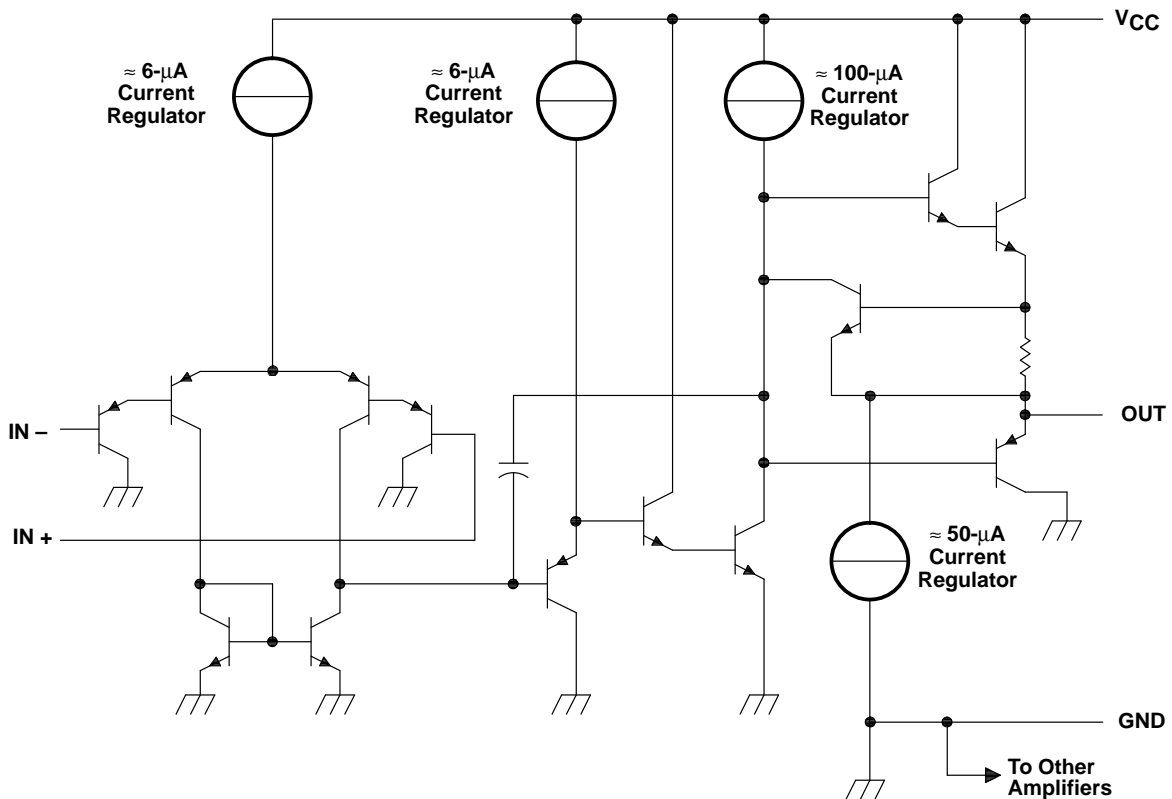
AVAILABLE OPTIONS

T _A	V _{IO} max AT 25°C	PACKAGED DEVICES							CHIP FORM (Y)
		SMALL OUTLINE (D)†	VERY SMALL OUTLINE (DB)‡	CHIP CARRIER (FK)	CERAMIC DIP (J)	PLASTIC DIP (N)	TSSOP (PW)‡	FLAT PACK (W)	
0°C to 70°C	7 mV 3 mV	LM324D LM324AD	LM324DBLE —	—	—	LM324N LM324AN	LM324PWLE LM324APWLE	—	LM324Y
25°C to 85°C	5 mV 3 mV	LM224D LM224AD	—	—	—	LM224N LM224AN	—	—	—
-40°C to 105°C	7 mV	LM2902D LM2902QD	LM2902DBLE	—	—	LM2902N LM2902QN	LM2902PWLE	—	—
-55°C to 125°C	5 mV 2 mV	—	—	LM124FK LM124AFK	LM124J LM124AJ	—	—	LM124W	—

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

‡ The DB and PW packages are only available left-end taped and reeled.

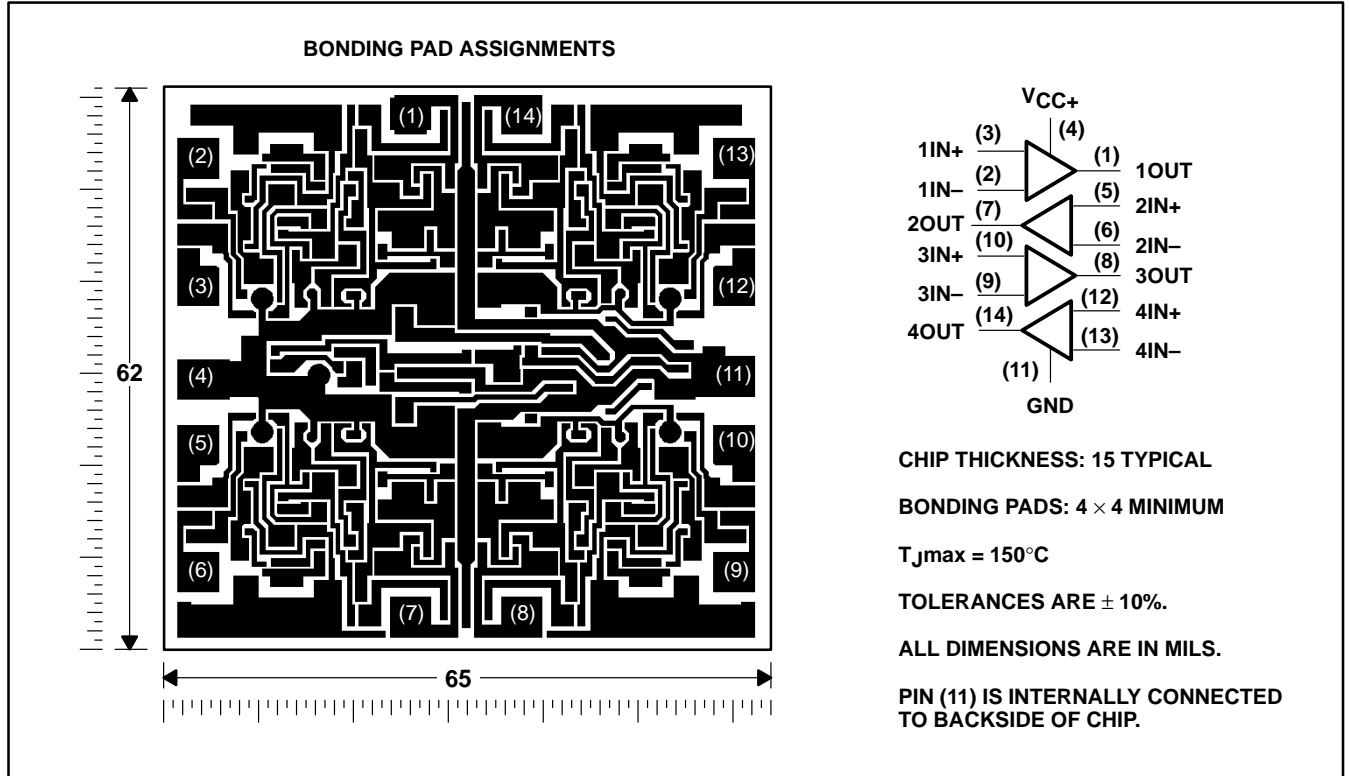
schematic (each amplifier)



COMPONENT COUNT (total device)	
Epi-FET	1
Transistors	95
Diodes	4
Resistors	11
Capacitors	4

LM324Y chip information

This chip, when properly assembled, displays characteristics similar to the LM324. Thermal compression or ultrasonic bonding may be used on the doped-aluminum bonding pads. Chips may be mounted with conductive epoxy or a gold-silicon preform.



**LM124, LM124A, LM224, LM224A
LM324, LM324A, LM324Y, LM2902, LM2902Q
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absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†

		LM124, LM124A LM224, LM224A LM324, LM324A	LM2902, LM2902Q	UNIT
Supply voltage, V_{CC} (see Note 1)		32	26	V
Differential input voltage, V_{ID} (see Note 2)		± 32	± 26	V
Input voltage, V_I (either input)		-0.3 to 32	-0.3 to 26	V
Duration of output short circuit (one amplifier) to ground at (or below) $T_A = 25^\circ\text{C}$, $V_{CC} \leq 15\text{ V}$ (see Note 3)		unlimited	unlimited	
Continuous total dissipation		See Dissipation Rating Table		
Operating free-air temperature range, T_A	LM124, LM124A	-55 to 125		°C
	LM224, LM224A	-25 to 85		
	LM324, LM324A	0 to 70		
	LM2902, LM2902Q		-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, DB, N, or PW package	260	260	°C

† Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

- NOTES: 1. All voltage values (except differential voltages and V_{CC} specified for the measurement of I_{OS}) are with respect to the network GND.
2. Differential voltages are at $IN+$ with respect to $IN-$.
3. Short circuits from outputs to V_{CC} can cause excessive heating and eventual destruction.

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	$T_A = 85^\circ\text{C}$ POWER RATING	$T_A = 125^\circ\text{C}$ POWER RATING
D	900 mW	7.6 mW/°C	32°C	608 mW	494 mW	N/A
DB	775 mW	6.2 mW/°C	25°C	496 mW	403 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
PW	700 mW	5.6 mW/°C	25°C	448 mW	364 mW	N/A
W	900 mW	8.0 mW/°C	37°C	640 mW	520 mW	200 mW

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

PARAMETER	TEST CONDITIONS†	T _A ‡	LM124, LM224			LM324			LM2902, LM2902Q			UNIT
			MIN	TYP§	MAX	MIN	TYP§	MAX	MIN	TYP§	MAX	
V _{IO} Input offset voltage	V _{CC} = 5 V to MAX, V _{IC} = V _{ICRmin} , V _O = 1.4 V	25°C	3	5	3	7	3	7	3	7	mV	
		Full range	7	7	9	10	10					
I _{IO} Input offset current	V _O = 1.4 V	25°C	2	30	2	50	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	-20	-250	nA	
		Full range	-300	-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	0 to V _{CC} -1.5	0 to V _{CC} -1.5	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	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 _{CC} -1.5	V _{CC} -1.5	V _{CC} -1.5	V _{CC} -1.5	V _{CC} -1.5	V _{CC} -1.5	V	
		25°C	26	26	22	22	22					
V _{OL} Low-level output voltage	R _L = 10 kΩ	25°C	27	28	27	28	23	24	23	24	mV	
		Full range	5	20	5	20	5	20	5	20		
A _{VD} Large-signal differential voltage amplification	V _{CC} = MAX, R _L ≥ 10 kΩ	25°C	50	100	25	100	100	100	100	100	V/mV	
		Full range	25	25	15	15	15					
CMRR Common-mode rejection ratio	V _{IC} = V _{ICRmin}	25°C	70	80	65	80	50	80	50	80	dB	
kSVR Supply-voltage rejection ratio (ΔV _{CC} /ΔV _O)		25°C	65	100	65	100	50	100	50	100	dB	
V _{O1} /V _{O2} Crosstalk attenuation	f = 1 kHz to 20 kHz	25°C	120	120	120	120	120	120	120	120	dB	
I _O Output current	V _{CC} = 15 V, V _{ID} = 1 V, V _O = 0	25°C	-20	-30	-20	-30	-20	-30	-20	-30	mA	
		Full range	-10	-10	-10	-10	-10					
I _{OS} Short-circuit output current	V _{CC} = 15 V, V _O = 15 V	25°C	10	20	10	20	10	20	10	20	mA	
		Full range	5	5	5	5	5					
I _{CC} Supply current (four amplifiers)	V _{ID} = -1 V, V _O = 200 mV	25°C	12	30	12	30	12	30	12	30	μA	
		25°C	±40	±60	±40	±60	±40	±60	±40	±60		
I _{CC} Supply current (four amplifiers)	V _{CC} at 5 V, GND at -5 V	25°C	0.7	1.2	0.7	1.2	0.7	1.2	0.7	1.2	mA	
		Full range	1.4	3	1.4	3	1.4	3	1.4	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 and LM2902Q, 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 and LM2902Q.

§ All typical values are at T_A = 25°C.



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

PARAMETER	TEST CONDITION [†]	T _A [‡]	LM124A			LM224A			LM324A			UNIT
			MIN	TYP [§]	MAX	MIN	TYP [§]	MAX	MIN	TYP [§]	MAX	
V _{IO}	V _{CC} = 5 V to 30 V, V _{IC} = V _{ICRmin} , V _O = 1.4 V	25°C		2	3		2	3		2	3	mV
		Full range		4	4		4	4		5	5	
I _{IO}	V _O = 1.4 V	25°C		10	2		15	2		2	30	nA
		Full range		30	30		30	30		75	75	
I _{IB}	V _O = 1.4 V	25°C		-50	-80		-15	-80		-15	-100	nA
		Full range		-100	-100		-100	-100		-200	-200	
V _{ICR}	V _{CC} = 30 V	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}	R _L = 2 kΩ	25°C										V
		Full range	26			26			26			
V _{OL}	R _L ≤ 10 kΩ	25°C										mV
		Full range	27	28	20	27	28	5	27	28	20	
A _{VD}	V _{CC} = 15 V, V _O = 1 V to 11 V, R _L ≥ 2 kΩ	25°C		25			25			15		V/mV
		Full range		70			70			65		
CMRR	V _{IC} = V _{ICRmin}	25°C		70			80			80		dB
kSVR	Supply-voltage rejection ratio ($\Delta V_{CC}/\Delta V_{IO}$)	25°C		65			100			100		dB
V _{O1} /V _{O2}	Crosstalk attenuation	25°C			120					120		dB
		25°C		-20	-60		-20	-60		-20	-60	
I _O	V _{CC} = 15 V, V _O = 0 V _{ID} = 1 V, V _{ID} = -1 V, V _O = 15 V	25°C										mA
		Full range		-10	-10		-10	-10		-10	-10	
I _{OS}	V _{CC} = 15 V, V _O = 15 V V _{ID} = -1 V, V _O = 200 mV	25°C		10	20		10	20		10	20	mA
		Full range		5	5		5	5		5	5	
I _{CC}	Short-circuit output current V _{CC} at 5 V, V _O = 0	25°C		12	30		12	30		12	30	μA
		25°C		±40	±60		±40	±60		±40	±60	mA
I _{CC}	Supply current (four amplifiers) V _{CC} = 30 V, V _O = 15 V, No load	25°C		0.7	1.2		0.7	1.2		0.7	1.2	mA
		Full range		1.4	3		1.4	3		1.4	3	

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

[‡] Full range is -55°C to 125°C for LM124A, -25°C to 85°C for LM224A, and 0°C to 70°C for LM324A.

[§] All typical values are at T_A = 25°C.



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electrical characteristics, $V_{CC} = 5\text{ V}$, $T_A = 25^\circ\text{C}$ (unless otherwise noted)

PARAMETER		TEST CONDITIONS†	LM324Y			UNIT
			MIN	TYP	MAX	
V_{IO}	Input offset voltage	$V_{CC} = 5\text{ V to MAX}, V_{IC} = V_{ICRmin}, V_O = 1.4\text{ V}$		3	7	mV
I_{IO}	Input offset current			2	50	nA
I_{IB}	Input bias current			-20	-250	nA
V_{ICR}	Common-mode input voltage range	$V_{CC} = 5\text{ V to MAX}$	0 to $V_{CC}-1.5$			V
V_{OH}	High-level output voltage	$R_L = 10\text{ k}\Omega$	$V_{CC}-1.5$			V
V_{OL}	Low-level output voltage	$R_L \leq 10\text{ k}\Omega$		5	20	mV
A_{VD}	Large-signal differential voltage amplification	$V_{CC} = 15\text{ V}, V_O = 1\text{ V to }11\text{ V}, R_L \geq 2\text{ k}\Omega$	15	100		V/mV
CMRR	Common-mode rejection ratio	$V_{IC} = V_{ICRmin}$	65	80		dB
k_{SVR}	Supply-voltage rejection ratio ($\Delta V_{CC\pm}/\Delta V_{IO}$)		65	100		dB
I_O	Output current	$V_{CC} = 15\text{ V}, V_{ID} = 1\text{ V}, V_O = 0$	-20	-30	-60	mA
		$V_{CC} = 15\text{ V}, V_{ID} = -1\text{ V}, V_O = 15\text{ V}$	10	20		
		$V_{ID} = 1\text{ V}, V_O = 200\text{ mV}$	12	30		
I_{OS}	Short-circuit output current	V_{CC} at 5 V, GND at -5 V, $V_O = 0$		± 40	± 60	mA
I_{CC}	Supply current (four amplifiers)	$V_O = 2.5 V_{CC},$ No load		0.7	1.2	mA
		$V_{CC} = \text{MAX},$ $V_O = 0.5 V_{CC},$ No load		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 30 V.

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