

- **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**

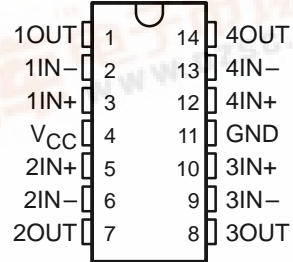
description

These devices consist of four independent high-gain frequency-compensated operational amplifiers that 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, 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.

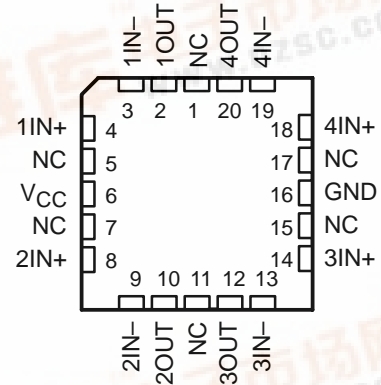
Applications include transducer amplifiers, dc amplification blocks, and all the conventional operational-amplifier circuits that now can be more easily implemented in single-supply-voltage systems. For example, the LM124 can be operated directly from the standard 5-V supply that is used in digital systems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

The 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 is characterized for operation from -40°C to 125°C .

LM124, LM124A . . . J OR W PACKAGE
 LM224, LM224A, LM324, LM324A,
 LM2902 . . . D, DB, N, OR PW PACKAGE
 (TOP VIEW)



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



NC – No internal connection



**LM124, LM124A, LM224, LM224A
LM324, LM324A, LM2902
QUADRUPLE OPERATIONAL AMPLIFIERS**

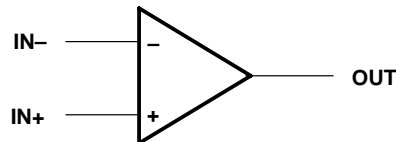
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AVAILABLE OPTIONS

T _A	V _{IO} MAX AT 25°C	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	LM324D	LM324DB	—	—	LM324N	LM324PW	—
	3 mV	LM324AD	—	—	—	LM324AN	LM324APW	—
-25°C to 85°C	5 mV	LM224D	—	—	—	LM224N	—	—
	3 mV	LM224AD	—	—	—	LM224AN	—	—
-40°C to 125°C	7 mV	LM2902D	LM2902DB	—	—	LM2902N	LM2902PW	—
-55°C to 125°C	5 mV	LM124D	—	LM124FK	LM124J	—	—	LM124W
	2 mV	—	—	LM124AFK	LM124AJ	—	—	—

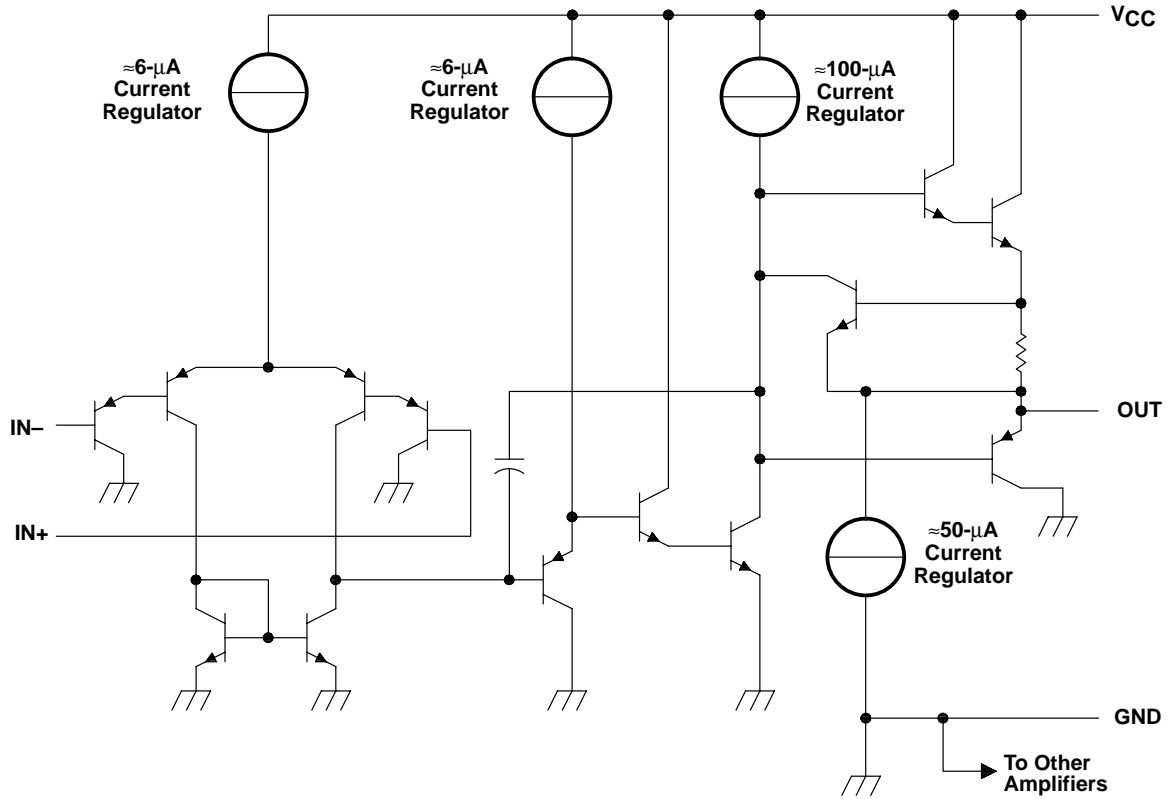
The D package is available taped and reeled. Add the suffix R to the device type (e.g., LM324DR). The DB and PW packages are only available taped and reeled.

symbol (each amplifier)



LM124, LM124A, LM224, LM224A
 LM324, LM324A, LM2902
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schematic (each amplifier)



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



**LM124, LM124A, LM224, LM224A
LM324, LM324A, LM2902
QUADRUPLE OPERATIONAL AMPLIFIERS**

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

		LM124, LM124A LM224, LM224A LM324, LM324A	LM2902	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		
Package thermal impedance, θ_{JA} (see Note 4)	D package	86		$^\circ\text{C/W}$
	DB package	96		
	N package	80		
	PW package	113		
Case temperature for 60 seconds	FK package	260		$^\circ\text{C}$
Lead temperature 1,6 mm (1/16 inch) from case for 60 seconds	J or W package	300	300	$^\circ\text{C}$
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds	D, DB, N, or PW package	260	260	$^\circ\text{C}$
Storage temperature range, T_{stg}		-65 to 150	-65 to 150	$^\circ\text{C}$

† 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.
4. The package thermal impedance is calculated in accordance with JESD 51-7.

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/ $^\circ\text{C}$	32 $^\circ\text{C}$	611 mW	497 mW	N/A
FK	900 mW	11.0 mW/ $^\circ\text{C}$	68 $^\circ\text{C}$	878 mW	713 mW	273 mW
J (LM124_)	900 mW	11.0 mW/ $^\circ\text{C}$	68 $^\circ\text{C}$	878 mW	713 mW	273 mW
J (all others)	900 mW	8.2 mW/ $^\circ\text{C}$	40 $^\circ\text{C}$	654 mW	531 mW	N/A
W	900 mW	8.0 mW/ $^\circ\text{C}$	37 $^\circ\text{C}$	636 mW	516 mW	196 mW



LM124, LM124A, LM224, LM224A
LM324, LM324A, LM2902
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electrical characteristics at specified free-air temperature, $V_{CC} = 5\text{ V}$ (unless otherwise noted)

PARAMETER	TEST CONDITIONS†	TA‡	LM124, LM224			LM324			LM2902			UNIT
			MIN	TYP§	MAX	MIN	TYP§	MAX	MIN	TYP§	MAX	
V_{IO}	$V_{CC} = 5\text{ V to MAX}$, $V_{IC} = V_{ICRmin}$, $V_O = 1.4\text{ V}$	25°C Full range	3	5	7	3	5	7	3	5	7	mV
I_{IO}	$V_O = 1.4\text{ V}$	25°C Full range	2	30	100	2	30	150	2	50	300	nA
I_{IB}	$V_O = 1.4\text{ V}$	25°C Full range	-20	-150	-300	-20	-150	-250	-20	-250	-500	nA
V_{ICR}	Common-mode input voltage range	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
V_{OH}	High-level output voltage	25°C	$V_{CC} - 1.5$			$V_{CC} - 1.5$			$V_{CC} - 1.5$			V
		Full range	26			26			22			V
V_{OL}	Low-level output voltage	25°C	27	28	20	27	28	24	23	24	20	mV
		Full range	5	20	20	5	20	20	5	20	20	mV
A_{VD}	$V_{CC} = 15\text{ V}$, $V_O = 1\text{ V to }11\text{ V}$, $R_L \geq 2\text{ k}\Omega$	25°C Full range	50	100		25	100		100			V/mV
$CMRR$	$V_{IC} = V_{ICRmin}$	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	25°C	120			120			120			dB
I_O	Output current	25°C	-20	-30	-60	-20	-30	-60	-20	-30	-60	mA
		Full range	-10			-10			-10			mA
I_{OS}	Short-circuit output current	25°C	10	20		10	20		10	20		mA
		Full range	5			5			5			mA
I_{CC}	Supply current (four amplifiers)	25°C	12	30		12	30		30			mA
		Full range	±40	±60		±40	±60		±40	±60		mA
		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		mA

† 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 125°C for LM2902.
 § All typical values are at $T_A = 25^\circ\text{C}$.

**LM124, LM124A, LM224, LM224A
LM324, LM324A, LM2902
QUADRUPLE OPERATIONAL AMPLIFIERS**
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electrical characteristics at specified free-air temperature, $V_{CC} = 5\text{ V}$ (unless otherwise noted)

PARAMETER	TEST CONDITIONS†	TA‡	LM124A			LM224A			LM324A			UNIT	
			MIN	TYP§	MAX	MIN	TYP§	MAX	MIN	TYP§	MAX		
V _{IO} Input offset voltage	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		4	5		
I _{IO} Input offset current	V _O = 1.4 V	25°C		10	2		15	2		2	30	nA	
		Full range		30	30		30	30		30	75		
I _{IB} Input bias current	V _O = 1.4 V	25°C		-50	-80		-15	-80		-15	-100	nA	
		Full range		-100	-100		-100	-100		-100	-200		
V _{ICR} Common-mode input voltage range	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} High-level output voltage	R _L = 2 kΩ	25°C	V _{CC} -1.5			V _{CC} -1.5			V _{CC} -1.5			V	
	V _{CC} = 30 V, R _L = 2 kΩ	Full range	26			26			26				
V _{OL} Low-level output voltage	V _{CC} = 30 V, R _L ≥ 10 kΩ	Full range	27		20	27		28	27		28	mV	
	R _L ≤ 10 kΩ	Full range							5		5		
A _{VD} Large-signal differential voltage amplification	V _{CC} = 15 V, V _O = 1 V to 11 V, R _L = ≥ 2 kΩ	Full range	25			25			15			V/mV	
CMRR Common-mode rejection ratio	V _{IC} = V _{ICRmin}	25°C	70			70		80	65		80	dB	
k _{SVR} Supply-voltage rejection ratio (ΔV _{CC} /ΔV _{IO})		25°C	65			65		100	65		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		-60	-20		-30	-20		-30	-60	mA
		Full range	-10			-10			-10				
I _{OS} Short-circuit output current	V _{CC} at 5 V, V _O = 0	25°C	10		20	10		20	10		20	mA	
		Full range	5			5			5				
I _{CC} Supply current (four amplifiers)	V _O = -1 V, V _O = 200 mV	25°C	12		30	12		30	12		30	μA	
		Full range											
I _{CC} Supply current (four amplifiers)	V _{CC} at 5 V, V _O = 0	25°C	±40		±60	±40		±60	±40		±60	mA	
		Full range	0.7		1.2	0.7		1.2	0.7		1.2	mA	
I _{CC} Supply current (four amplifiers)	V _{CC} = 30 V, No load	25°C	1.4		3	1.4		3	1.4		3	mA	
		Full range											

† 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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