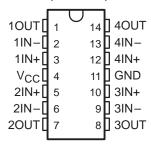
- Wide Range of Supply Voltages: Single Supply . . . 3 V to 30 V (LM2902 and LM2902Q 3 V to 26 V), or Dual Supplies
- Low Supply Current Drain Independent of Supply Voltage . . . 0.8 mA Typ
- Common-Mode Input Voltage Range Includes Ground Allowing Direct Sensing Near Ground
- Low Input Bias and Offset 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

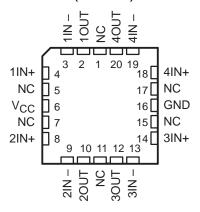
description

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.

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

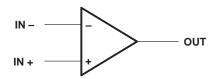


LM124, LM124A . . . FK PACKAGE (TOP VIEW)



NC - No internal connection

symbol (each amplifier)



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 125°C.



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

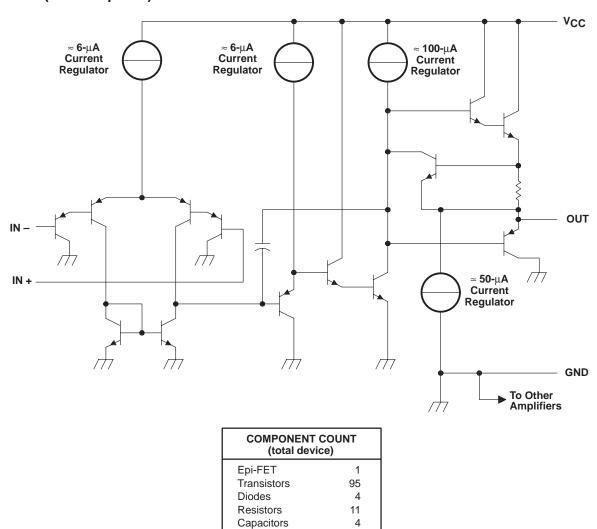


AVAILABLE OPTIONS

	PACKAGED DEVICES								
TA	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)	CHIP FORM (Y)
0°C to	7 mV	LM324D	LM324DBLE	_	_	LM324N	LM324PWLE	_	L \$400.4V
70°C	3 mV	LM324AD	_	_	_	LM324AN	LM324APWLE	_	LM324Y
−25°C to	5 mV	LM224D	_	_	_	LM224N	_	_	
85°C	3 mV	LM224AD	_	_	_	LM224AN	_	_	_
−40°C to	°C to LM290		LM2902DBLE	_	_	LM2902N	LM2902PWLE	_	
125°C	7 mV	LM2902QD	LIVI2902DBLE	_	_	LM2902QN	LIVI2902FVVLE	_	
−55°C to	5 mV	_	_	LM124FK	LM124J	_	_	LM124W	
125°C	2 mV	_	_	LM124AFK	LM124AJ	_	_		

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

schematic (each amplifier)

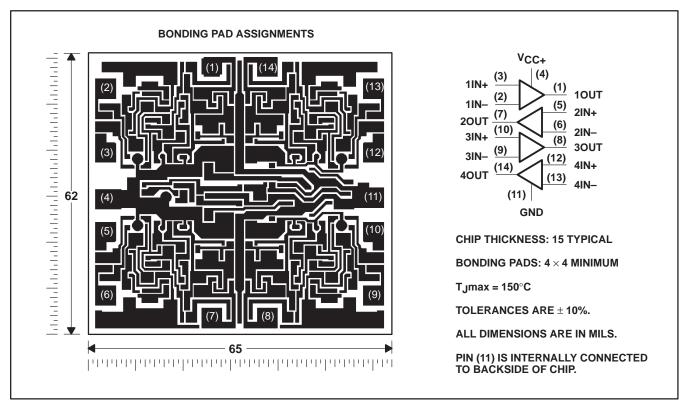




[‡] The DB and PW packages are only available left-end taped and reeled.

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 QUADRUPLE OPERATIONAL AMPLIFIERS

SLOS066D - SEPTEMBER 1975 - REVISED SEPTEMBER 1996

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 be $V_{CC} \le 15 \text{ V}$ (see Note 3)	unlimited	unlimited				
Continuous total dissipation		See Dissipation Rating Table				
	LM124, LM124A	-55 to 125				
Operating free air temperature range. To	LM224, LM224A	-25 to 85		°C		
Operating free-air temperature range, T _A	LM324, LM324A	0 to 70		, C		
	LM2902, LM2902Q		-40 to 125			
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 VCC specified for the measurement of IOS) 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	$T_{\mbox{A}} \le 25^{\circ}\mbox{C}$ 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	611 mW	497 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	878 mW	713 mW	273 mW
J (LM124_)	900 mW	11.0 mW/°C	68°C	878 mW	713 mW	273 mW
J (all others)	900 mW	8.2 mW/°C	40°C	654 mW	531 mW	N/A
N	900 mW	9.2 mW/°C	52°C	734 mW	596 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	636 mW	516 mW	196 mW

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

PARAMETER		TEST CONDITIONS†		T. İ	LM124, LM224		LM324			LM2902, LM2902Q			UNIT			
	FARAWLIER	TEST CON	DITIONS	T _A ‡	MIN	TYP§	MAX	MIN	TYP§	MAX	MIN	TYP§	MAX	UNIT		
VIO	Input offset voltage	$V_{CC} = 5 \text{ V to MAX},$ $V_{IC} = V_{ICR} \text{min}, V_{O} = 1.4 \text{ V}$		25°C		3	5		3	7		3	7	mV		
VIO	input onset voltage			Full range			7			9			10	IIIV		
110	Input offset current	V _O = 1.4 V		25°C		2	30		2	50		2	50	nA		
10	input onset ourrent	VO = 1.4 V	VO = 1.4 V		VO = 1.4 V	Full range			100			150			300	11/ (
I _{IB}	Input bias current	V _O = 1.4 V		25°C		-20	-150		-20	-250		-20	-250	nA		
,ID	mpat blad darront	v0= v		Full range			-300			-500			-500			
VICR	Common-mode input			25°C	0 to V _{CC} - 1.5			0 to V _{CC} – 1.5			0 to V _{CC} -1 .5					
	voltage range	V _{CC} = 5 V to MA		Full range	0 to V _{CC} - 2			0 to V _{CC} - 2			0 to V _{CC} -2			V		
		R _L = 2 kΩ		25°C	V _{CC} - 1.5			V _{CC} - 1.5								
VOH	High-level output voltage	R _L = 10 kΩ		25°C							V _{CC} -1 .5			V		
		V _{CC} = MAX,	R _L = 2 kΩ	Full range	26			26			22					
		V _{CC} = MAX,	$R_L \ge 10 \text{ k}\Omega$	Full range	27	28		27	28		23	24				
V_{OL}	Low-level output voltage	$R_L \le 10 \text{ k}\Omega$		Full range		5	20		5	20		5	100	mV		
A _{VD}	Large-signal differential voltage amplification	$V_{CC} = 15 \text{ V, } V_{O}$ $R_{L} = \ge 2 \text{ k}\Omega$	= 1 V to 11 V,	25°C Full range	50 25	100		25 15	100		15	100		V/mV		
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 (ΔVCC/ΔVIO)			25°C	65	100		65	100		50	100		dB		
V _{O1} /V _{O2}	Crosstalk attenuation	f = 1 kHz to 20 k	Hz	25°C		120			120			120		dB		
		V _{CC} = 15 V,	V _{ID} = 1 V,	25°C	-20	-30	-60	-20	-30	-60	-20	-30	-60			
		V _O = 0	ייי טוי	Full range	-10			-10			-10			,		
IO	Output current	V _{CC} = 15 V,	V _{ID} = -1 V,	25°C	10	20		10	20		10	20		mA		
		V _O = 15 V		Full range	5			5			5					
1		$V_{ID} = -1 V$,	V _O = 200 mV	25°C	12	30		12	30			30		μΑ		
los	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		
		V _O = 2.5 V,	No load	Full range		0.7	1.2		0.7	1.2		0.7	1.2			
Icc	Supply current (four amplifiers)	$V_{CC} = MAX,$ $V_{O} = 0.5 V_{CC},$	No load	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 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 125°C for LM2902 and LM2902Q.

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

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

			T _A ‡	LM124A			LM224A			LM324A					
	PARAMETER		TEST CONDITIONST		MIN	TYP§	MAX	MIN	TYP§	MAX	MIN	TYP§	MAX	UNIT	
		V _{CC} = 5 V to 30	0 V,	25°C			2		2	3		2	3	.,	
VIO	Input offset voltage	V _{IC} = V _{ICR} min		Full range			4			4			5	mV	
	1	V 44V		25°C			10			2	15	2	30	- 4	
110	Input offset current	V _O = 1.4 V		Full range			30			30			75	nA	
1	Input bias current	V _O = 1.4 V		25°C			-50		-15	-80		-15	-100	nA	
IB	input bias current	VO = 1.4 V		Full range			-100			-100			-200	IIA	
\\	Common-mode input	V 20 V		25°C	0 to V _{CC} -1.5			0 to V _{CC} -1.5			0 to V _{CC} -1.5			٧	
VICR	voltage range	V _{CC} = 30 V		Full range	0 to V _{CC} -2			0 to V _{CC} -2			0 to V _{CC} -2			V	
		$R_L = 2 k\Omega$		25°C	V _{CC} -1.5			V _{CC} -1.5			V _{CC} -1.5			V	
VOH	High-level output voltage	$V_{CC} = 30 \text{ V},$	$R_L = 2 k\Omega$	Full range	26			26			26				
		$V_{CC} = 30 \text{ V},$	$R_L \ge 10 \text{ k}\Omega$	Full range	27			27	28		27	28			
V_{OL}	Low-level output voltage	$R_L \le 10 \text{ k}\Omega$		Full range			20		5	20		5	20	mV	
A _{VD}	Large-signal differential voltage amplification	$V_{CC} = 15 \text{ V}, V_{C}$ $R_{L} = 2 \text{ k}\Omega$) = 1 V to 11 V,	Full range	25			25			15			V/mV	
CMRR	Common-mode rejection ratio	V _{IC} = V _{ICR} min		25°C	70			70	80		65	80		dB	
ksvr	Supply-voltage rejection ratio $(\Delta V_{CC}/\Delta V_{IO})$			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	
		V _{CC} = 15 V,	V _{ID} = 1 V,	25°C	-20			-20	-30	-60	-20	-30	-60		
		V _O = 0		Full range	-10			-10			-10			mA	
IO	Output current	V _{CC} = 15 V,	V _{ID} = −1 V,	25°C	10			10	20		10	20			
		V _O = 15 V		Full range	5			5			5				
		$V_{ID} = -1 V$,	V _O = 200 mV	25°C	12			12	30		12	30		μΑ	
los	Short-circuit output current	V_{CC} at 5 V, $V_{O} = 0$	GND at −5 V,	25°C		±40	±60		±40	±60		±40	±60	mA	
	<u> </u>	$V_0 = 2.5 V$,	No load	Full range		0.7	1.2		0.7	1.2		0.7	1.2		
ICC	Supply current (four amplifiers)	V _{CC} = 30 V, No load	V _O = 15 V,	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. ‡ 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.

electrical characteristics, V_{CC} = 5 V, T_A = 25°C (unless otherwise noted)

	DADAMETED	TEC	LN	LINUT				
	PARAMETER	IES	T CONDITIONS†		MIN	TYP	MAX	UNIT
۷ıO	Input offset voltage					3	7	mV
lιο	Input offset current	$V_{CC} = 5 V \text{ to } MAX,$	$V_{IC} = V_{ICR}min,$	$V_0 = 1.4 \text{ V}$		2	50	nA
I _{IB}	Input bias current					-20	-250	nA
VICR	Common-mode input voltage range	V _{CC} = 5 V to MAX			0 to V _{CC} -1.5			V
Vон	High-level output voltage	R _L = 10 kΩ			V _{CC} -1.5			V
VOL	Low-level output voltage	$R_L \le 10 \text{ k}\Omega$				5	20	mV
A _{VD}	Large-signal differential voltage amplification	V _{CC} = 15 V,	V _O = 1 V to 11 V,	$R_L \ge 2 k\Omega$	15	100		V/mV
CMRR	Common-mode rejection ratio	V _{IC} = V _{ICR} min			65	80		dB
ksvr	Supply-voltage rejection ratio $(\Delta V_{CC\pm}/\Delta V_{IO})$				65	100		dB
		V _{CC} = 15 V,	V _{ID} = 1 V,	VO = 0	-20	-30	-60	
IO	Output current	V _{CC} = 15 V,	$V_{ID} = -1 V$,	V _O = 15 V	10	20		mA
		V _{ID} = 1 V,	V _O = 200 mV		12	30		
los	Short-circuit output current	V _{CC} at 5 V,	GND at −5 V,	VO = 0		±40	±60	mA
laa	Supply ourrant (four amplificant)	$V_{O} = 2.5 V_{CC}$	No load			0.7	1.2	m /\
Icc	Supply current (four amplifiers)	V _{CC} = MAX,	V _O = 0.5 V _{CC} ,	No load		1.1	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 30 V.



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