

# LM124, LM124A, LM224, LM224A, LM324, LM324A, LM2902, LM2902V, LM224K, LM224KA, LM324K, LM324KA, LM2902K, LM2902KV, LM2902KAV QUADRUPLE OPERATIONAL AMPLIFIERS

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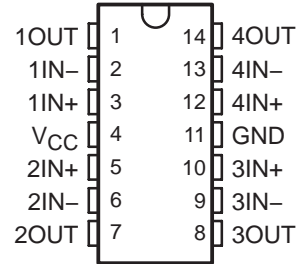
- **2-kV ESD Protection for:**
  - LM224K, LM224KA
  - LM324K, LM324KA
  - LM2902K, LM2902KV, LM2902KAV
- **Wide Supply Ranges**
  - Single Supply . . . 3 V to 32 V  
(26 V for LM2902)
  - Dual Supplies . . .  $\pm 1.5$  V to  $\pm 16$  V  
( $\pm 13$  V for LM2902)
- **Low Supply-Current Drain Independent 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/ordering information

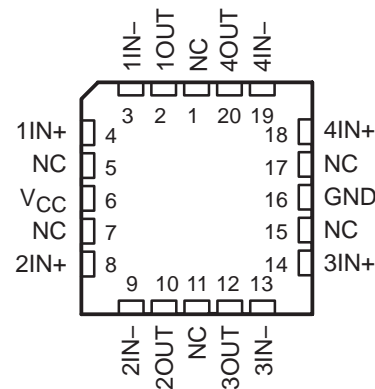
These devices consist of four independent high-gain frequency-compensated operational amplifiers that are designed specifically to operate from a single supply over a wide range of voltages. Operation from split supplies also is possible if the difference between the two supplies is 3 V to 32 V (3 V to 26 V for the LM2902), 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 provides the required interface electronics, without requiring additional  $\pm 15$ -V supplies.

LM124 . . . D, J, OR W PACKAGE  
LM124A . . . J PACKAGE  
LM224, LM224A, LM224K, LM224KA . . . D OR N PACKAGE  
LM324, LM324K . . . D, N, NS, OR PW PACKAGE  
LM324A . . . D, DB, N, NS, OR PW PACKAGE  
LM324KA . . . D, N, NS, OR PW PACKAGE  
LM2902 . . . D, N, NS, OR PW PACKAGE  
LM2902K . . . D, DB, N, NS, OR PW PACKAGE  
LM2902KV, LM2902KAV . . . D OR PW PACKAGE  
(TOP VIEW)



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



NC – No internal connection

**LM124, LM124A, LM224, LM224A, LM324, LM324A, LM2902, LM2902V,  
LM224K, LM224KA, LM324K, LM324KA, LM2902K, LM2902KV, LM2902KAV  
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**description/ordering information (continued)**

**ORDERING INFORMATION**

<b>T<sub>A</sub></b>	<b>V<sub>IO</sub>max AT 25°C</b>	<b>MAX TESTED V<sub>CC</sub></b>	<b>PACKAGE†</b>		<b>ORDERABLE PART NUMBER</b>	<b>TOP-SIDE MARKING</b>
0°C to 70°C	7 mV	30 V	PDIP (N)	Tube of 25	LM324N	LM324N
					LM324KN	LM324KN
			SOIC (D)	Tube of 50	LM324D	LM324
				Reel of 2500	LM324DR	
				Tube of 50	LM324KD	LM324K
				Reel of 2500	LM324KDR	
			SOP (NS)	Reel of 2000	LM324NSR	LM324
				Tube of 50	LM324KNS	LM324K
				Reel of 2000	LM324KNSR	
			TSSOP (PW)	Tube of 90	LM324PW	L324
				Reel of 2000	LM324PWR	
				Tube of 90	LM324KPW	L324K
				Reel of 2000	LM324KPWR	
	3 mV	30 V	PDIP (N)	Tube of 25	LM324AN	LM324AN
				Tube of 25	LM324KAN	LM324KAN
			SOIC (D)	Tube of 50	LM324AD	LM324A
				Reel of 2500	LM324ADR	
				Tube of 50	LM324KAD	LM324KA
				Reel of 2500	LM324KADR	
			SOP (NS)	Reel of 2000	LM324ANSR	LM324A
				Tube of 50	LM324KANS	LM324KA
				Reel of 2000	LM324KANSR	
			SSOP (DB)	Reel of 2000	LM324ADBR	LM324A
			TSSOP (PW)	Tube of 90	LM324APW	L324A
				Reel of 2000	LM324APWR	
				Tube of 90	LM324KAPW	L324KA
				Reel of 2000	LM324KAPWR	
–25°C to 85°C	5 mV	30 V	PDIP (N)	Tube of 25	LM224N	LM224N
					LM224KN	LM224KN
			SOIC (D)	Tube of 50	LM224D	LM224
				Reel of 2500	LM224DR	
				Tube of 50	LM224KD	LM224K
				Reel of 2500	LM224KDR	
	3 mV	30 V	PDIP (N)	Tube of 25	LM224AN	LM224AN
				Tube of 25	LM224KAN	LM224KAN
			SOIC (D)	Tube of 50	LM224AD	LM224A
				Reel of 2500	LM224ADR	
				Tube of 50	LM224KAD	LM224KA
				Reel of 2500	LM224KADR	

† Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at [www.ti.com/sc/package](http://www.ti.com/sc/package).



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**LM124, LM124A, LM224, LM224A, LM324, LM324A, LM2902, LM2902V,  
LM224K, LM224KA, LM324K, LM324KA, LM2902K, LM2902KV, LM2902KAV  
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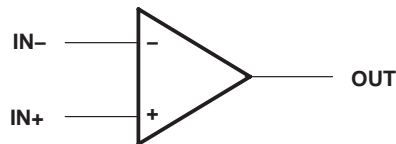
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**ORDERING INFORMATION (CONTINUED)**

$T_A$	$V_{IOmax}$ AT 25°C	MAX TESTED $V_{CC}$	PACKAGE†		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 125°C	7 mV	26 V	PDIP (N)	Tube of 25	LM2902N	LM2902N
				Tube of 25	LM2902KN	LM2902KN
			SOIC (D)	Tube of 50	LM2902D	LM2902
				Reel of 2500	LM2902DR	
				Tube of 50	LM2902KD	LM2902K
				Reel of 2500	LM2902KDR	
			SOP (NS)	Reel of 2000	LM2902NSR	LM2902
				Tube of 50	LM2902KNS	LM2902K
				Reel of 2000	LM2902KNSR	
			SSOP (DB)	Tube of 80	LM2902KDB	L2902K
				Reel of 2000	LM2902KDBR	
			TSSOP (PW)	Tube of 90	LM2902PW	L2902
				Reel of 2000	LM2902PWR	
				Tube of 90	LM2902KPW	L2902K
				Reel of 2000	LM2902KPWR	
–55°C to 125°C	5 mV	30 V	SOIC (D)	Reel of 2500	LM2902KVQDR	L2902KV
			TSSOP (PW)	Reel of 2000	LM2902KVQPWR	L2902KV
			SOIC (D)	Reel of 2500	LM2902KAVQDR	L2902KA
			TSSOP (PW)	Reel of 2000	LM2902KAVQPWR	L2902KA
	2 mV	30 V	CDIP (J)	Tube of 25	LM124J	LM124J
			CFP (W)	Tube of 25	LM124W	LM124W
			LCCC (FK)	Tube of 55	LM124FK	LM124FK
			SOIC (D)	Tube of 50	LM124D	LM124
				Reel of 2500	LM124DR	
			CDIP (J)	Tube of 25	LM124AJ	LM124AJ
			LCCC (FK)	Tube of 55	LM124AFK	LM124AFK

† Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at [www.ti.com/sc/package](http://www.ti.com/sc/package).

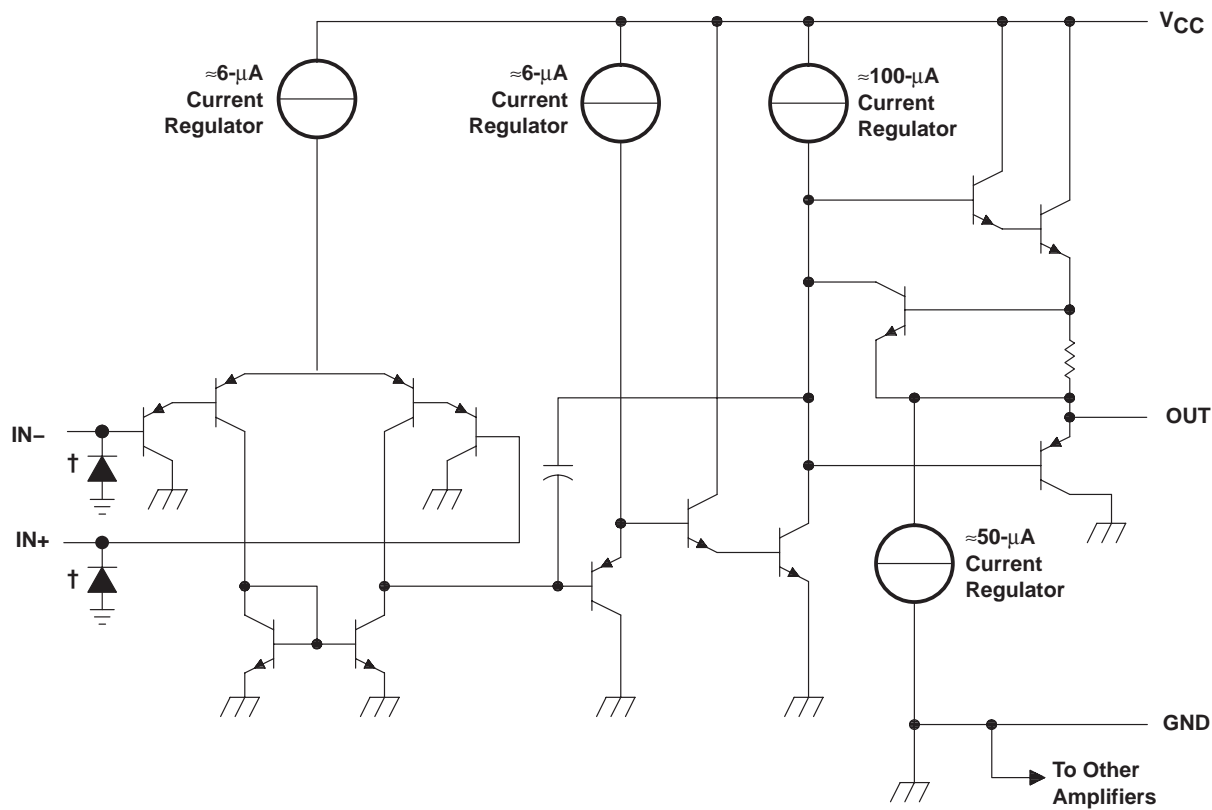
**symbol (each amplifier)**



LM124, LM124A, LM224, LM224A, LM324, LM324A, LM2902, LM2902V,  
LM224K, LM224KA, LM324K, LM324KA, LM2902K, LM2902KV, LM2902KAV  
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schematic (each amplifier)



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

† ESD protection cells - available on LM324K and LM324KA only

**LM124, LM124A, LM224, LM224A, LM324, LM324A, LM2902, LM2902V,  
LM224K, LM224KA, LM324K, LM324KA, LM2902K, LM2902KV, LM2902KAV**  
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**absolute maximum ratings over operating free-air temperature range (unless otherwise noted)<sup>†</sup>**

		LM2902	ALL OTHER DEVICES	UNIT
Supply voltage, $V_{CC}$ (see Note 1)		$\pm 13$ or 26	$\pm 16$ or 32	V
Differential input voltage, $V_{ID}$ (see Note 2)		$\pm 26$	$\pm 32$	V
Input voltage, $V_I$ (either input)		-0.3 to 26	-0.3 to 32	V
Duration of output short circuit (one amplifier) to ground at (or below) $T_A = 25^\circ\text{C}$ , $V_{CC} \leq 15$ V (see Note 3)		Unlimited	Unlimited	
Package thermal impedance, $\theta_{JA}$ (see Notes 4 and 5)	D package	86	86	$^\circ\text{C/W}$
	DB package	96	96	
	N package	80	80	
	NS package	76	76	
	PW package	113	113	
Package thermal impedance, $\theta_{JC}$ (see Notes 6 and 7)	FK package		5.61	$^\circ\text{C/W}$
	J package		15.05	
	W package		14.65	
Operating virtual junction temperature, $T_J$		150	150	$^\circ\text{C}$
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	$^\circ\text{C}$
Storage temperature range, $T_{stg}$		-65 to 150	-65 to 150	$^\circ\text{C}$

<sup>†</sup> 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. Maximum power dissipation is a function of  $T_J(\text{max})$ ,  $\theta_{JA}$ , and  $T_A$ . The maximum allowable power dissipation at any allowable ambient temperature is  $P_D = (T_J(\text{max}) - T_A)/\theta_{JA}$ . Operating at the absolute maximum  $T_J$  of  $150^\circ\text{C}$  can affect reliability.
  5. The package thermal impedance is calculated in accordance with JEDEC 51-7.
  6. Maximum power dissipation is a function of  $T_J(\text{max})$ ,  $\theta_{JC}$ , and  $T_C$ . The maximum allowable power dissipation at any allowable case temperature is  $P_D = (T_J(\text{max}) - T_C)/\theta_{JC}$ . Operating at the absolute maximum  $T_J$  of  $150^\circ\text{C}$  can affect reliability.
  7. The package thermal impedance is calculated in accordance with MIL-STD-883.

## ESD protection

TEST CONDITIONS		TYP	UNIT
Human-Body Model	LM224K, LM224KA, LM324K, LM324KA, LM2902K, LM2902KV, LM2902KAV	$\pm 2$	kV



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

PARAMETER			TEST CONDITIONS†	T <sub>A</sub> ‡	LM124 LM224			LM324 LM324K			UNIT
					MIN	TYP§	MAX	MIN	TYP§	MAX	
V <sub>IO</sub>	Input offset voltage	V <sub>CC</sub> = 5 V to MAX, V <sub>IC</sub> = V <sub>ICRmin</sub> , V <sub>O</sub> = 1.4 V		25°C	3		5	3		7	mV
				Full range			7			9	
I <sub>IO</sub>	Input offset current	V <sub>O</sub> = 1.4 V		25°C	2		30	2		50	nA
				Full range			100			150	
I <sub>IB</sub>	Input bias current	V <sub>O</sub> = 1.4 V		25°C	–20		–150	–20		–250	nA
				Full range			–300			–500	
V <sub>ICR</sub>	Common-mode input voltage range	V <sub>CC</sub> = 5 V to MAX		25°C	0 to V <sub>CC</sub> – 1.5			0 to V <sub>CC</sub> – 1.5			V
				Full range	0 to V <sub>CC</sub> – 2			0 to V <sub>CC</sub> – 2			
V <sub>OH</sub>	High-level output voltage	R <sub>L</sub> = 2 kΩ		25°C	V <sub>CC</sub> – 1.5			V <sub>CC</sub> – 1.5			V
		R <sub>L</sub> = 10 kΩ		25°C							
		V <sub>CC</sub> = MAX	R <sub>L</sub> = 2 kΩ	Full range	26				26		
			R <sub>L</sub> ≥ 10 kΩ	Full range	27		28		27		
V <sub>OL</sub>	Low-level output voltage	R <sub>L</sub> ≤ 10 kΩ		Full range	5		20	5		20	mV
A <sub>VD</sub>	Large-signal differential voltage amplification	V <sub>CC</sub> = 15 V, V <sub>O</sub> = 1 V to 11 V, R <sub>L</sub> ≥ 2 kΩ		25°C	50	100		25	100		V/mV
				Full range	25		15				
CMRR	Common-mode rejection ratio	V <sub>IC</sub> = V <sub>ICRmin</sub>		25°C	70	80		65	80		dB
k <sub>SVR</sub>	Supply-voltage rejection ratio (ΔV <sub>CC</sub> /ΔV <sub>IO</sub> )			25°C	65	100		65	100		dB
V <sub>O1</sub> /V <sub>O2</sub>	Crosstalk attenuation	f = 1 kHz to 20 kHz		25°C	120			120			dB
I <sub>O</sub>	Output current	V <sub>CC</sub> = 15 V, V <sub>ID</sub> = 1 V, V <sub>O</sub> = 0	Source	25°C	–20	–30	–60	–20	–30	–60	mA
				Full range	–10		–10				
		V <sub>CC</sub> = 15 V, V <sub>ID</sub> = –1 V, V <sub>O</sub> = 15 V	Sink	25°C	10		20	10		20	
				Full range	5		5				
		V <sub>ID</sub> = –1 V, V <sub>O</sub> = 200 mV	25°C	12		30	12		30	μA	
I <sub>OS</sub>	Short-circuit output current	V <sub>CC</sub> at 5 V, GND at –5 V	V <sub>O</sub> = 0,	25°C	±40		±60	±40	±60	mA	
I <sub>CC</sub>	Supply current (four amplifiers)	V <sub>O</sub> = 2.5 V, No load	Full range	0.7		1.2	0.7		1.2	mA	
		V <sub>CC</sub> = MAX, V <sub>O</sub> = 0.5 V <sub>CC</sub> , No load	Full range	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 30 V for the others.

‡ Full range is –55°C to 125°C for LM124, –25°C to 85°C for LM224, and 0°C to 70°C for LM324.

§ All typical values are at  $T_A = 25^\circ\text{C}$ .



**LM124, LM124A, LM224, LM224A, LM324, LM324A, LM2902, LM2902V,  
LM224K, LM224KA, LM324K, LM324KA, LM2902K, LM2902KV, LM2902KAV**  
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**electrical characteristics at specified free-air temperature,  $V_{CC} = 5\text{ V}$  (unless otherwise noted)**

PARAMETER		TEST CONDITIONS†		T <sub>A</sub> ‡	LM2902			LM2902V			UNIT
					MIN	TYP§	MAX	MIN	TYP§	MAX	
V <sub>IO</sub>	Input offset voltage	V <sub>CC</sub> = 5 V to MAX, V <sub>IC</sub> = V <sub>ICRmin</sub> , V <sub>O</sub> = 1.4 V	Non-A-suffix devices	25°C	3	7		3	7	mV	
				Full range		10		10			
		A-suffix devices	25°C				1	2			
			Full range					4			
ΔV <sub>IO</sub> /ΔT	Input offset voltage temperature drift	R <sub>S</sub> = 0 Ω		Full range				7		μV/°C	
I <sub>IO</sub>	Input offset current	V <sub>O</sub> = 1.4 V		25°C	2	50		2	50	nA	
				Full range		300		150			
ΔI <sub>IO</sub> /ΔT	Input offset current temperature drift			Full range				10		pA/°C	
I <sub>IB</sub>	Input bias current	V <sub>O</sub> = 1.4 V		25°C	–20	–250		–20	–250	nA	
				Full range		–500		–500			
V <sub>ICR</sub>	Common-mode input voltage range	V <sub>CC</sub> = 5 V to MAX		25°C	0 to V <sub>CC</sub> – 1.5		0 to V <sub>CC</sub> – 1.5		V		
				Full range	0 to V <sub>CC</sub> – 2		0 to V <sub>CC</sub> – 2				
V <sub>OH</sub>	High-level output voltage	R <sub>L</sub> = 2 kΩ		25°C					V		
		R <sub>L</sub> = 10 kΩ		25°C	V <sub>CC</sub> – 1.5		V <sub>CC</sub> – 1.5				
		V <sub>CC</sub> = MAX	R <sub>L</sub> = 2 kΩ	Full range	22		26				
			R <sub>L</sub> ≥ 10 kΩ	Full range	23      24		27				
V <sub>OL</sub>	Low-level output voltage	R <sub>L</sub> ≤ 10 kΩ		Full range	5      20		5      20		mV		
A <sub>VD</sub>	Large-signal differential voltage amplification	V <sub>CC</sub> = 15 V, V <sub>O</sub> = 1 V to 11 V, R <sub>L</sub> ≥ 2 kΩ		25°C	25	100		25	100	V/mV	
				Full range	15		15				
CMRR	Common-mode rejection ratio	V <sub>IC</sub> = V <sub>ICRmin</sub>		25°C	50	80		60	80	dB	
k <sub>SVR</sub>	Supply-voltage rejection ratio (ΔV <sub>CC</sub> /ΔV <sub>IO</sub> )			25°C	50	100		60	100	dB	
V <sub>O1</sub> /V <sub>O2</sub>	Crosstalk attenuation	f = 1 kHz to 20 kHz		25°C	120		120		dB		
I <sub>O</sub>	Output current	V <sub>CC</sub> = 15 V, V <sub>ID</sub> = 1 V, V <sub>O</sub> = 0	Source	25°C	–20	–30	–60	–20	–30	–60	mA
				Full range	–10		–10				
		V <sub>CC</sub> = 15 V, V <sub>ID</sub> = –1 V, V <sub>O</sub> = 15 V	Sink	25°C	10	20		10	20		
				Full range	5		5				
		V <sub>ID</sub> = –1 V,      V <sub>O</sub> = 200 mV		25°C	30		12      40		μA		
I <sub>OS</sub>	Short-circuit output current	V <sub>CC</sub> at 5 V, GND at –5 V	V <sub>O</sub> = 0,	25°C	±40	±60		±40	±60	mA	
I <sub>CC</sub>	Supply current (four amplifiers)	V <sub>O</sub> = 2.5 V,	No load	Full range	0.7	1.2		0.7	1.2	mA	
		V <sub>CC</sub> = MAX, V <sub>O</sub> = 0.5 V <sub>CC</sub> ,	No load	Full range	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  $26\text{ V}$  for LM2902 and  $32\text{ V}$  for LM2902V.

‡ Full range is  $-40^\circ\text{C}$  to  $125^\circ\text{C}$  for LM2902.

§ All typical values are at  $T_A = 25^\circ\text{C}$ .

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LM224K, LM224KA, LM324K, LM324KA, LM2902K, LM2902KV, LM2902KAV**  
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electrical characteristics at specified free-air temperature,  $V_{CC} = 5\text{ V}$  (unless otherwise noted)

PARAMETER	TEST CONDITIONS†	T <sub>A</sub> ‡	LM124A			LM224A			LM324A, LM324KA			UNIT
			MIN	TYP§	MAX	MIN	TYP§	MAX	MIN	TYP§	MAX	
V <sub>IO</sub> Input offset voltage	V <sub>CC</sub> = 5 V to 30 V, V <sub>IC</sub> = V <sub>ICRmin</sub> , V <sub>O</sub> = 1.4 V	25°C			2		2	3		2	3	mV
		Full range			4			4			5	
I <sub>IO</sub> Input offset current	V <sub>O</sub> = 1.4 V	25°C			10		2	15		2	30	nA
		Full range			30			30			75	
I <sub>IB</sub> Input bias current	V <sub>O</sub> = 1.4 V	25°C			–50		–15	–80		–15	–100	nA
		Full range			–100			–100			–200	
V <sub>ICR</sub> Common-mode input voltage range	V <sub>CC</sub> = 30 V	25°C	0 to V <sub>CC</sub> – 1.5			0 to V <sub>CC</sub> – 1.5			0 to V <sub>CC</sub> – 1.5			V
		Full range	0 to V <sub>CC</sub> – 2			0 to V <sub>CC</sub> – 2			0 to V <sub>CC</sub> – 2			
V <sub>OH</sub> High-level output voltage	R <sub>L</sub> = 2 kΩ V <sub>CC</sub> = 30 V	25°C	V <sub>CC</sub> – 1.5			V <sub>CC</sub> – 1.5			V <sub>CC</sub> – 1.5			V
		Full range	26			26			26			
V <sub>OL</sub> Low-level output voltage	R <sub>L</sub> ≤ 10 kΩ R <sub>L</sub> ≥ 10 kΩ	Full range	27			27			27			mV
		Full range			20		5	20		5	20	
A <sub>VD</sub> Large-signal differential voltage amplification	V <sub>CC</sub> = 15 V, V <sub>O</sub> = 1 V to 11 V, R <sub>L</sub> ≥ 2 kΩ	25°C	50	100		50	100		25	100		V/mV
		Full range	25			25			15			
CMRR Common-mode rejection ratio	V <sub>IC</sub> = V <sub>ICRmin</sub>	25°C	70			70	80		65	80		dB
kSVR Supply-voltage rejection ratio (ΔV <sub>CC</sub> /ΔV <sub>IO</sub> )		25°C	65			65	100		65	100		dB
V <sub>O1</sub> /V <sub>O2</sub> Crosstalk attenuation	f = 1 kHz to 20 kHz	25°C		120								dB
I <sub>O</sub> Output current	V <sub>CC</sub> = 15 V, V <sub>ID</sub> = 1 V, V <sub>O</sub> = 0	Source	–20			–20	–30	–60	–20	–30	–60	mA
		Sink	–10			–10			–10			
	V <sub>CC</sub> = 15 V, V <sub>ID</sub> = –1 V, V <sub>O</sub> = 15 V		10			10	20		10	20		
			5			5			5			
I <sub>OS</sub> Short-circuit output current	V <sub>ID</sub> = –1 V, V <sub>CC</sub> at 5 V, V <sub>O</sub> = 0	25°C	12			12	30		12	30		μA
I <sub>CC</sub> Supply current (four amplifiers)	V <sub>O</sub> = 2.5 V, V <sub>CC</sub> = 30 V, No load	25°C		±40	±60		±40	±60		±40	±60	mA
		Full range		0.7	1.2		0.7	1.2		0.7	1.2	
		Full range		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  $T_A = 25^\circ\text{C}$ .



**LM124, LM124A, LM224, LM224A, LM324, LM324A, LM2902, LM2902V,  
LM224K, LM224KA, LM324K, LM324KA, LM2902K, LM2902KV, LM2902KAV**  
**QUADRUPLE OPERATIONAL AMPLIFIERS**

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operating conditions,  $V_{CC} = \pm 15\text{ V}$ ,  $T_A = 25^\circ\text{C}$

PARAMETER		TEST CONDITIONS	TYP	UNIT
SR	Slew rate at unity gain	$R_L = 1\text{ M}\Omega$ , $C_L = 30\text{ pF}$ , $V_I = \pm 10\text{ V}$ (see Figure 1)	0.5	$\text{V}/\mu\text{s}$
$B_1$	Unity-gain bandwidth	$R_L = 1\text{ M}\Omega$ , $C_L = 20\text{ pF}$ (see Figure 1)	1.2	MHz
$V_n$	Equivalent input noise voltage	$R_S = 100\text{ }\Omega$ , $V_I = 0\text{ V}$ , $f = 1\text{ kHz}$ (see Figure 2)	35	$\text{nV}/\sqrt{\text{Hz}}$

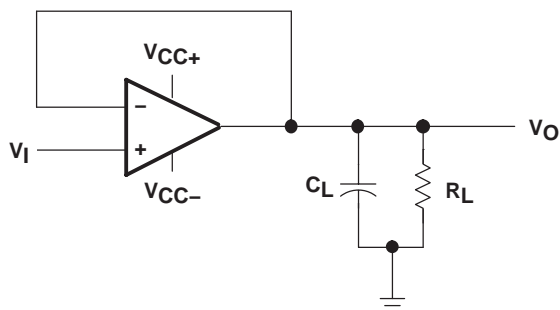


Figure 1. Unity-Gain Amplifier

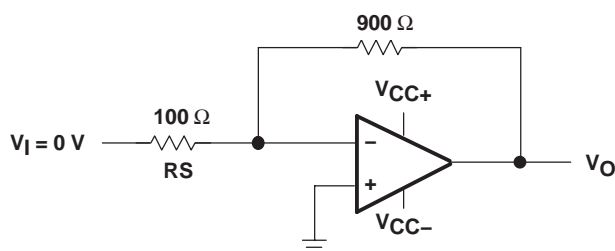


Figure 2. Noise-Test Circuit

**PACKAGING INFORMATION**

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/Ball Finish	MSL Peak Temp <sup>(3)</sup>
5962-7704301VCA	ACTIVE	CDIP	J	14	1	TBD	A42 SNPB	Level-NC-NC-NC
77043012A	ACTIVE	LCCC	FK	20	1	TBD	POST-PLATE	Level-NC-NC-NC
7704301CA	ACTIVE	CDIP	J	14	1	TBD	A42 SNPB	Level-NC-NC-NC
7704301DA	ACTIVE	CFP	W	14	1	TBD	A42 SNPB	Level-NC-NC-NC
77043022A	ACTIVE	LCCC	FK	20	1	TBD	POST-PLATE	Level-NC-NC-NC
7704302CA	ACTIVE	CDIP	J	14	1	TBD	A42 SNPB	Level-NC-NC-NC
JM38510/11005BCA	ACTIVE	CDIP	J	14	1	TBD	A42 SNPB	Level-NC-NC-NC
LM124AFKB	ACTIVE	LCCC	FK	20	1	TBD	POST-PLATE	Level-NC-NC-NC
LM124AJ	ACTIVE	CDIP	J	14	1	TBD	A42 SNPB	Level-NC-NC-NC
LM124AJB	ACTIVE	CDIP	J	14	1	TBD	A42 SNPB	Level-NC-NC-NC
LM124D	ACTIVE	SOIC	D	14	50	TBD	CU NIPDAU	Level-3-245C-168 HR
LM124DR	ACTIVE	SOIC	D	14	2500	TBD	CU NIPDAU	Level-3-245C-168 HR
LM124FKB	ACTIVE	LCCC	FK	20	1	TBD	POST-PLATE	Level-NC-NC-NC
LM124J	ACTIVE	CDIP	J	14	1	TBD	A42 SNPB	Level-NC-NC-NC
LM124JB	ACTIVE	CDIP	J	14	1	TBD	A42 SNPB	Level-NC-NC-NC
LM124N	OBSOLETE	PDIP	N	14		TBD	Call TI	Call TI
LM124W	ACTIVE	CFP	W	14	1	TBD	A42 SNPB	Level-NC-NC-NC
LM124WB	ACTIVE	CFP	W	14	1	TBD	A42 SNPB	Level-NC-NC-NC
LM224AD	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM224ADE4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM224ADR	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM224ADRE4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM224AN	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	Level-NC-NC-NC
LM224D	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM224DE4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM224DR	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM224DRE4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM224KAD	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM224KADE4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM224KADR	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM224KADRE4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM224KAN	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	Level-NC-NC-NC

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/Ball Finish	MSL Peak Temp <sup>(3)</sup>
LM224KANE4	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	Level-NC-NC-NC
LM224KD	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM224KDE4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM224KDR	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM224KDRE4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM224KN	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	Level-NC-NC-NC
LM224KNE4	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	Level-NC-NC-NC
LM224N	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	Level-NC-NC-NC
LM2902D	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM2902DE4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM2902DG4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM2902DR	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM2902DRE4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM2902DRG4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM2902KAVQDR	ACTIVE	SOIC	D	14	2500	Pb-Free (RoHS)	CU NIPDAU	Level-2-250C-1 YEAR/ Level-1-235C-UNLIM
LM2902KAVQPWR	ACTIVE	TSSOP	PW	14	2000	TBD	CU NIPDAU	Level-1-250C-UNLIM
LM2902KD	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM2902KDB	ACTIVE	SSOP	DB	14	80	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM2902KDBE4	ACTIVE	SSOP	DB	14	80	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM2902KDBR	ACTIVE	SSOP	DB	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM2902KDBRE4	ACTIVE	SSOP	DB	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM2902KDE4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM2902KDR	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM2902KDRE4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM2902KN	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	Level-NC-NC-NC
LM2902KNE4	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	Level-NC-NC-NC

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/Ball Finish	MSL Peak Temp <sup>(3)</sup>
LM2902KNSR	ACTIVE	SO	NS	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM2902KNSRE4	ACTIVE	SO	NS	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM2902KPW	ACTIVE	TSSOP	PW	14	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM2902KPWE4	ACTIVE	TSSOP	PW	14	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM2902KPWR	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM2902KPWRE4	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM2902KVQDR	ACTIVE	SOIC	D	14	2500	Pb-Free (RoHS)	CU NIPDAU	Level-2-250C-1 YEAR/ Level-1-235C-UNLIM
LM2902KVQPWR	ACTIVE	TSSOP	PW	14	2000	TBD	CU NIPDAU	Level-1-250C-UNLIM
LM2902N	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	Level-NC-NC-NC
LM2902NE4	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	Level-NC-NC-NC
LM2902NSR	ACTIVE	SO	NS	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM2902NSRG4	ACTIVE	SO	NS	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM2902PW	ACTIVE	TSSOP	PW	14	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM2902PWE4	ACTIVE	TSSOP	PW	14	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM2902PWG4	ACTIVE	TSSOP	PW	14	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM2902PWLE	OBSOLETE	TSSOP	PW	14		TBD	Call TI	Call TI
LM2902PWR	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM2902PWRE4	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM2902PWRG4	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM2902QN	OBSOLETE	PDIP	N	14		TBD	Call TI	Call TI
LM324AD	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM324ADBLE	OBSOLETE	SSOP	DB	14		TBD	Call TI	Call TI
LM324ADBR	ACTIVE	SSOP	DB	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM324ADBRE4	ACTIVE	SSOP	DB	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM324ADE4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM324ADR	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM324ADRE4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM324AN	ACTIVE	PDIP	N	14	25	Pb-Free	CU NIPDAU	Level-NC-NC-NC

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/Ball Finish	MSL Peak Temp <sup>(3)</sup>
(RoHS)								
LM324ANE4	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	Level-NC-NC-NC
LM324ANSR	ACTIVE	SO	NS	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM324ANSRE4	ACTIVE	SO	NS	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM324APW	ACTIVE	TSSOP	PW	14	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM324APWE4	ACTIVE	TSSOP	PW	14	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM324APWG4	ACTIVE	TSSOP	PW	14	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM324APWLE	OBSOLETE	TSSOP	PW	14		TBD	Call TI	Call TI
LM324APWR	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM324APWRE4	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM324APWRG4	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM324D	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM324DE4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM324DG4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM324DR	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM324DRE4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM324DRG4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM324KAD	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM324KADG4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM324KADR	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM324KADRG4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM324KAN	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	Level-NC-NC-NC
LM324KANE4	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	Level-NC-NC-NC
LM324KANS	PREVIEW	SO	NS	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM324KANSR	ACTIVE	SO	NS	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM324KANSRE4	ACTIVE	SO	NS	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM324KAPW	ACTIVE	TSSOP	PW	14	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/Ball Finish	MSL Peak Temp <sup>(3)</sup>
no Sb/Br)								
LM324KAPWG4	ACTIVE	TSSOP	PW	14	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM324KAPWR	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM324KAPWRG4	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM324KD	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM324KDE4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM324KDR	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM324KDRE4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM324KN	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	Level-NC-NC-NC
LM324KNS	PREVIEW	SO	NS	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM324KNSR	ACTIVE	SO	NS	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM324KNSRE4	ACTIVE	SO	NS	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM324KPW	ACTIVE	TSSOP	PW	14	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM324KPWE4	ACTIVE	TSSOP	PW	14	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM324KPWR	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM324KPWRE4	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM324N	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	Level-NC-NC-NC
LM324NE4	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	Level-NC-NC-NC
LM324NSR	ACTIVE	SO	NS	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM324NSRE4	ACTIVE	SO	NS	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM324NSRG4	ACTIVE	SO	NS	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM324PW	ACTIVE	TSSOP	PW	14	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM324PWE4	ACTIVE	TSSOP	PW	14	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM324PWG4	ACTIVE	TSSOP	PW	14	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM324PWLE	OBSOLETE	TSSOP	PW	14		TBD	Call TI	Call TI
LM324PWR	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM324PWRE4	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/Ball Finish	MSL Peak Temp <sup>(3)</sup>
no Sb/Br)								
LM324PWRG4	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
LM324Y	OBSOLETE	XCEPT	Y	0		TBD	Call TI	Call TI

<sup>(1)</sup> The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSOLETE:** TI has discontinued the production of the device.

<sup>(2)</sup> Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS) or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

<sup>(3)</sup> MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

**Important Information and Disclaimer:** The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

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J (R-GDIP-T\*\*)

14 LEADS SHOWN

# CERAMIC DUAL IN-LINE PACKAGE



PINS ** DIM	14	16	18	20
A	0.300 (7,62) BSC	0.300 (7,62) BSC	0.300 (7,62) BSC	0.300 (7,62) BSC
B MAX	0.785 (19,94)	.840 (21,34)	0.960 (24,38)	1.060 (26,92)
B MIN	—	—	—	—
C MAX	0.300 (7,62)	0.300 (7,62)	0.310 (7,87)	0.300 (7,62)
C MIN	0.245 (6,22)	0.245 (6,22)	0.220 (5,59)	0.245 (6,22)



4040083/F 03/03

- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - C. This package is hermetically sealed with a ceramic lid using glass frit.
  - D. Index point is provided on cap for terminal identification only on press ceramic glass frit seal only.
  - E. Falls within MIL STD 1835 GDIP1-T14, GDIP1-T16, GDIP1-T18 and GDIP1-T20.



W (R-GDFP-F14)

CERAMIC DUAL FLATPACK



- NOTES:
- All linear dimensions are in inches (millimeters).
  - This drawing is subject to change without notice.
  - This package can be hermetically sealed with a ceramic lid using glass frit.
  - Index point is provided on cap for terminal identification only.
  - Falls within MIL STD 1835 GDFP1-F14 and JEDEC MO-092AB

## FK (S-CQCC-N\*\*)

## LEADLESS CERAMIC CHIP CARRIER

28 TERMINAL SHOWN



- NOTES:
- All linear dimensions are in inches (millimeters).
  - This drawing is subject to change without notice.
  - This package can be hermetically sealed with a metal lid.
  - The terminals are gold plated.
  - Falls within JEDEC MS-004

## N (R-PDIP-T\*\*)

16 PINS SHOWN

## PLASTIC DUAL-IN-LINE PACKAGE



PINS **	14	16	18	20
DIM				
A MAX	0.775 (19,69)	0.775 (19,69)	0.920 (23,37)	1.060 (26,92)
A MIN	0.745 (18,92)	0.745 (18,92)	0.850 (21,59)	0.940 (23,88)
MS-001 VARIATION	AA	BB	AC	AD



14/18 Pin Only  
20 Pin vendor option

4040049/E 12/2002

- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - Falls within JEDEC MS-001, except 18 and 20 pin minimum body length (Dim A).
  - The 20 pin end lead shoulder width is a vendor option, either half or full width.

## D (R-PDSO-G14)

## PLASTIC SMALL-OUTLINE PACKAGE



- NOTES:
- All linear dimensions are in inches (millimeters).
  - This drawing is subject to change without notice.
  - Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
  - Falls within JEDEC MS-012 variation AB.

# MECHANICAL DATA

NS (R-PDSO-G\*\*)

PLASTIC SMALL-OUTLINE PACKAGE

14-PINS SHOWN



- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Body dimensions do not include mold flash or protrusion, not to exceed 0,15.

## DB (R-PDSO-G\*\*)

## PLASTIC SMALL-OUTLINE

28 PINS SHOWN



- NOTES: A. All linear dimensions are in millimeters.  
 B. This drawing is subject to change without notice.  
 C. Body dimensions do not include mold flash or protrusion not to exceed 0,15.  
 D. Falls within JEDEC MO-150

## PW (R-PDSO-G\*\*)

## PLASTIC SMALL-OUTLINE PACKAGE

14 PINS SHOWN



- NOTES: A. All linear dimensions are in millimeters.  
 B. This drawing is subject to change without notice.  
 C. Body dimensions do not include mold flash or protrusion not to exceed 0,15.  
 D. Falls within JEDEC MO-153

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