Quadruple Operational Amplifiers

1 Features

- Wide Supply Ranges
  - Single Supply: 3 V to 32 V (26 V for LM2902)
  - Dual Supplies: ±1.5 V to ±16 V (±13 V for LM2902)
- Low Supply-Current Drain Independent of Supply Voltage: 0.8 mA Typical
- Common-Mode Input Voltage Range Includes Ground, Allowing Direct Sensing Near Ground
- Low Input Bias and Offset Parameters
  - Input Offset Voltage: 3 mV Typical
  - Input Offset Current: 2 nA Typical
  - Input Bias Current: 20 nA Typical
- Differential Input Voltage Range Equal to Maximum-Rated Supply Voltage: 32 V (26 V for LM2902)
- Open-Loop Differential Voltage Amplification: 100 V/mV Typical
- Internal Frequency Compensation
- On Products Compliant to MIL-PRF-38535, All Parameters are Tested Unless Otherwise Noted. On All Other Products, Production Processing Does Not Necessarily Include Testing of All Parameters.

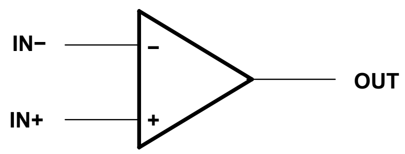
2 Applications

- Blu-ray Players and Home Theaters
- Chemical and Gas Sensors
- DVD Recorders and Players
- Digital Multimeter: Bench and Systems
- Digital Multimeter: Handhelds
- Field Transmitter: Temperature Sensors
- Motor Control: AC Induction, Brushed DC, Brushless DC, High-Voltage, Low-Voltage, Permanent Magnet, and Stepper Motor
- Oscilloscopes
- TV: LCD and Digital
- Temperature Sensors or Controllers Using Modbus
- Weigh Scales

3 Description

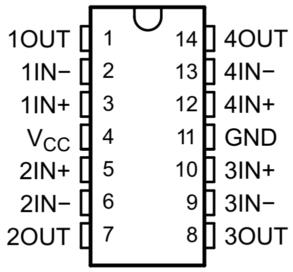
These devices consist of four independent high-gain frequency-compensated operational amplifiers that are designed specifically to operate from a single supply or split supply over a wide range of voltages.

Symbol (Each Amplifier)



4 Pin Configuration and Functions

DR
14-Pin SOP, DIP



Pin Functions

PIN			I/O	DESCRIPTION
NAME	LCCC NO.	SOP, DIP		
1IN–		2	I	Negative input
1IN+		3	I	Positive input
1OUT		1	O	Output
2IN–		6	I	Negative input
2IN+		5	I	Positive input
2OUT		7	O	Output
3IN–		9	I	Negative input
3IN+		10	I	Positive input
3OUT		8	O	Output
4IN–		13	I	Negative input
4IN+		12	I	Positive input
4OUT		14	O	Output
GND		11	—	Ground
V_{CC}	6	4	—	Power supply

5 Specifications

5.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)(1)

	LM2902		LM124, LM224		UNIT
	MIN	MAX	MIN	MAX	
Supply voltage, V_{CC} (2)	±13	26	±16	32	V
Differential input voltage, V_{ID} (3)		±26		±32	V
Input voltage, V_I (either input)	–0.3	26	–0.3	to 32	V
Duration of output short circuit (one amplifier) to ground at (or below) T_A = 25°C, $V_{CC} \leq$ 15 V(4)	Unlimited		Unlimited		
Operating virtual junction temperature, T_J		150		150	°C
Storage temperature, T_{stg}	–65	150	–65	150	°C

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

5.2 ESD

LM124, LM224, LM2902				
$V_{(ESD)}$	Electrostatic discharge	Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001(1)	±500	V
		Charged-device model (CDM), per JEDEC specification JESD22-C101	±1000	

(1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.

5.3 Recommended Operating Conditions

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

		LM2902		LM124, LM224		UNIT
		MIN	MAX	MIN	MAX	
V_{CC} Supply voltage		3	26	3	30	V
V_{CM} Common-mode voltage		0	V_{CC} – 2	0	V_{CC} – 2	V
T_A Operating free air temperature	LM124			–55	125	°C
	LM2902	–40	105			
	LM224			–20	85	

5.4 Thermal Information

THERMAL METRIC (1)		LM124,LM224, LM2902 (SOP) 14 PINS	LM124,LM224, LM2902 (DIP) 14 PINS	UNIT
$R_{\theta JA}$ (2) (3)	Junction-to-ambient thermal resistance	86	80	°C/W
$R_{\theta JC}$ (4)	Junction-to-case (top) thermal resistance	—	—	°C/W

(1) Short circuits from outputs to VCC can cause excessive heating and eventual destruction.
(2) Maximum power dissipation is a function of $T_{J(max)}$, $R_{\theta JA}$, and T_A. The maximum allowable power dissipation at any allowable ambient temperature is $P_D = (T_{J(max)} - T_A)/R_{\theta JA}$. Operating at the absolute maximum T_J of 150°C can affect reliability.
(3) Maximum power dissipation is a function of $T_{J(max)}$, $R_{\theta JA}$, and T_C. The maximum allowable power dissipation at any allowable case temperature is $P_D = (T_{J(max)} - T_C)/R_{\theta JC}$. Operating at the absolute maximum T_J of 150°C can affect reliability.

5.5 Electrical Characteristics for LMx24

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

PARAMETER		TEST CONDITIONS (1)		T_A (2)	LM124, LM224 MIN	TYP (3)	MAX	UNIT
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	mV
				Full range			7	
I_{IO}	Input offset current	V_O = 1.4 V		25°C		2	30	nA
				Full range			100	
I_{IB}	Input bias current	V_O = 1.4 V		25°C		–20	–150	nA
				Full range			–300	
V_{ICR}	Common-mode input voltage range	V_{CC} = 5 V to MAX		25°C	0 to $V_{CC} - 1.5$			V
				Full range	0 to $V_{CC} - 2$			
V_{OH}	High-level output voltage	R_L = 2 kΩ		25°C	$V_{CC} - 1.5$			V
		R_L = 10 kΩ		25°C				
		V_{CC} = MAX	R_L = 2 kΩ	Full range	26			
			R_L ≥ 10 kΩ	Full range	27	28		
V_{OL}	Low-level output voltage	R_L ≤ 10 kΩ		Full range		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		V/mV
				Full range	25			
CMRR	Common-mode rejection ratio	$V_{IC} = V_{ICR}$min		25°C	70	80		dB
k_{SVR}	Supply-voltage rejection ratio (ΔV_{CC} /ΔVIO)			25°C	65	100		dB
V_{O1}/ V_{O2}	Crosstalk attenuation	f = 1 kHz to 20 kHz		25°C		120		dB
I_O	Output current	V_{CC} = 15 V, V_{ID} = 1 V, V_O = 0	Source	25°C	–20	–30	–60	mA
				Full range	–10			
		V_{CC} = 15 V, V_{ID} = –1 V, V_O = 15 V	Sink	25°C	10	20		
				Full range	5			
		V_{ID} = –1 V, V_O = 200 mV		25°C	12	30		μA
I_{OS}	Short-circuit output current	V_{CC} at 5 V, V_O = 0, GND at –5 V		25°C		±40	±60	mA
I_{CC}	Supply current (four amplifiers)	V_O = 2.5 V, no load		Full range		0.7	1.2	mA
		V_{CC} = MAX, V_O = 0.5 V_{CC}, no load		Full range		1.4	3	

(1) 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.
(2) Full range is –55°C to 125°C for LM124, –20°C to 85°C for LM224
(3) All typical values are at T_A = 25°C

5.6 Operating Conditions

V_{CC} = ±15 V, T_A = 25°C

PARAMETER		TEST CONDITIONS	TYP	UNIT
SR	Slew rate at unity gain	R_L = 1 MΩ, C_L = 30 pF, V_I = ±10 V (see Figure 7)	0.5	V/μs
B_1	Unity-gain bandwidth	R_L = 1 MΩ, C_L = 20 pF (see Figure 7)	1.2	MHz
V_n	Equivalent input noise voltage	R_S = 100 Ω, V_I = 0 V, f = 1 kHz (see Figure 8)	35	nV/√Hz

5.7 Typical Characteristics

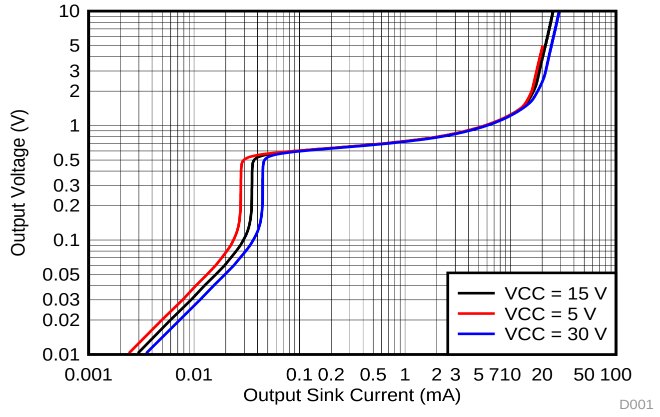


Figure 1. Output Sinking Characteristics

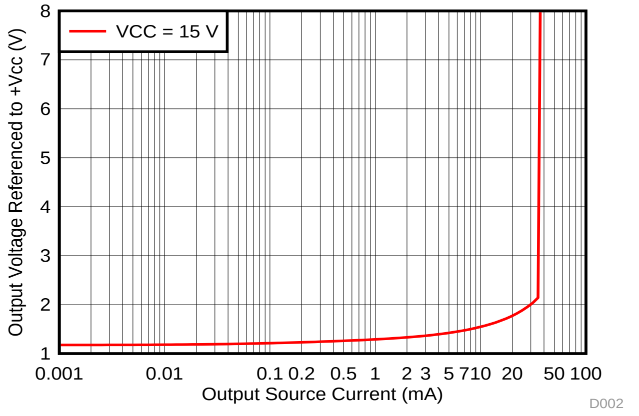


Figure 2. Output Sourcing Characteristics

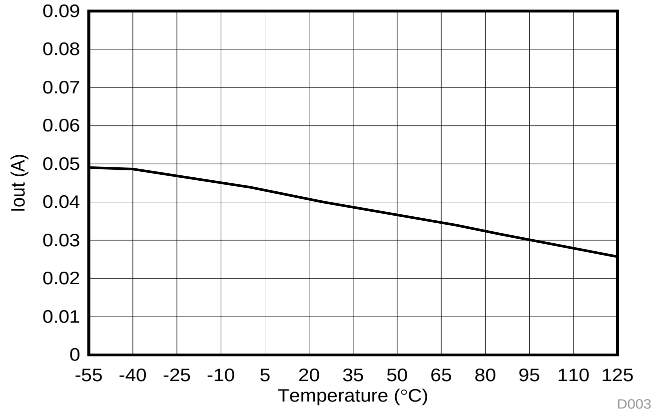


Figure 3. Source Current Limiting

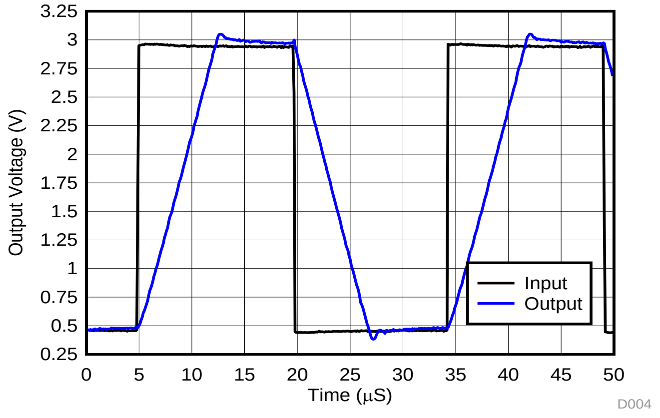


Figure 4. Voltage Follower Large Signal Response (50 pF)

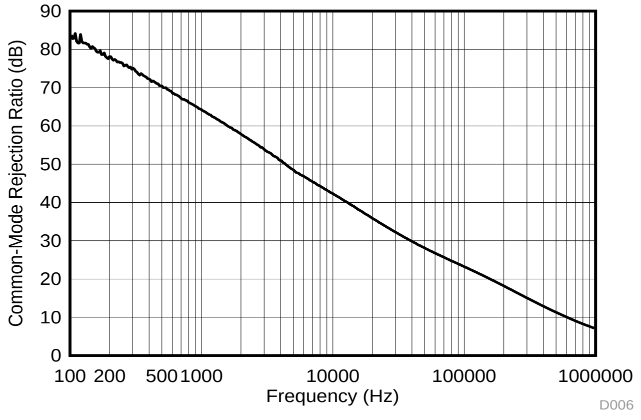


Figure 5. Common-Mode Rejection Ratio

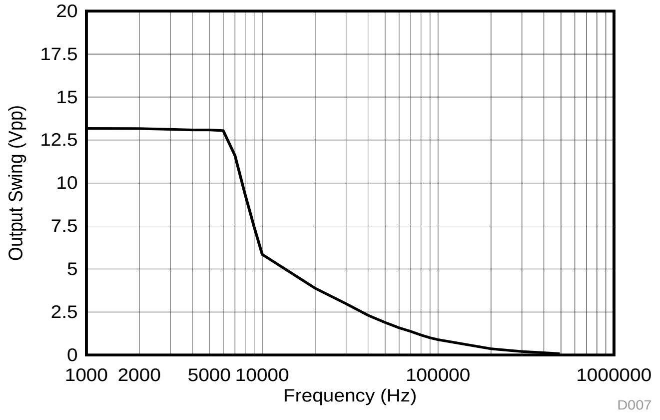


Figure 6. Maximum Output Swing vs. Frequency (VCC = 15 V)

6 Parameter Measurement Information

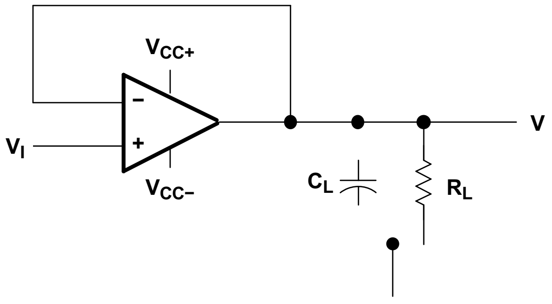


Figure 7. Unity-Gain Amplifier

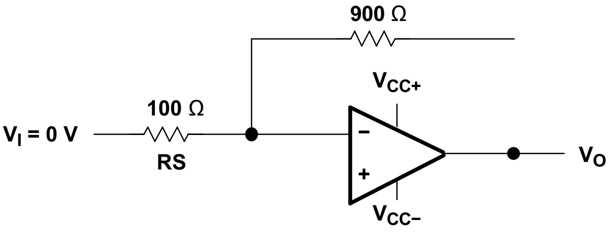


Figure 8. Noise-Test Circuit

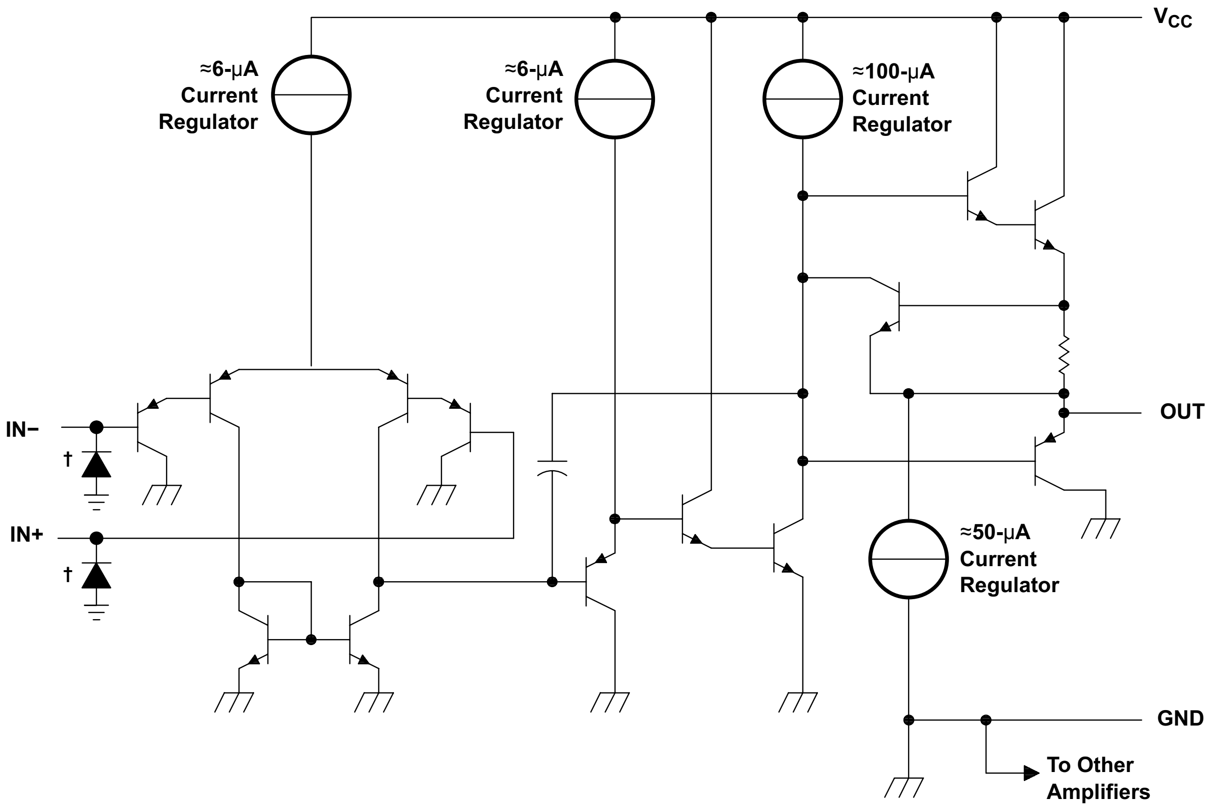
7 Detailed Description

7.1 Overview

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 device), 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 device 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 ±15-V supplies.

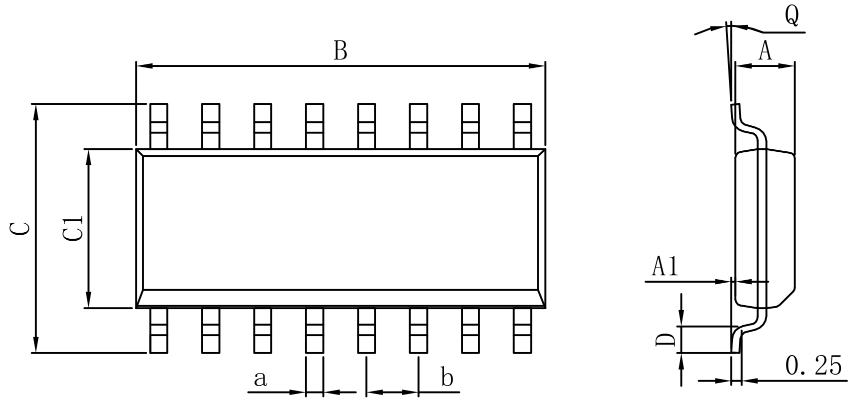
7.2 Functional Block Diagram



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

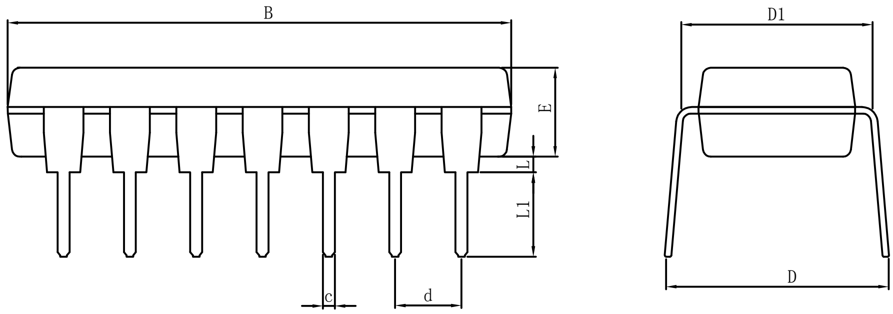
PACKAGE

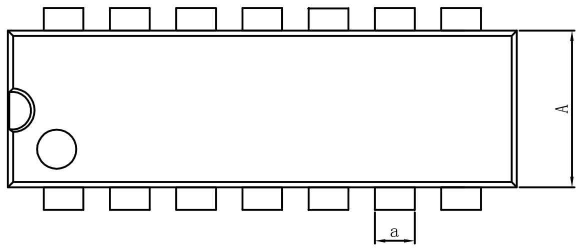
SOP14



UNIT: mm							
DIM.	MIN	TYP	MAX	DIM.	MIN	TYP	MAX
A	4. 520	4. 570	4. 620	a	0. 400	0. 420	0. 440
A1	0. 100	–	0. 250	b	1. 260	1. 270	1. 280
B	8. 500	8. 750	9. 000	Q	0°	–	8°
C	5. 800	6. 100	6. 250				
C1	3. 800	3. 900	4. 000				
D	0. 400	–	0. 950				

DIP14





UNIT: mm							
DIM.	MIN	TYP	MAX	DIM.	MIN	TYP	MAX
A	6. 100	6. 300	6. 680	a	1. 504	1. 524	1. 544
B	18. 940	19. 200	19. 560	c	0. 437	0. 457	0. 477
D	8. 200	8. 700	9. 200	d	2. 530	2. 540	2. 550
D1	7. 42	7. 62	7. 82	L	0. 500	–	0. 800
E	3. 100	3. 300	3. 550	L1	3. 000	3. 200	3. 600