LM124/324
Low Power Quad Operational Amplifiers

FEATURES

- Internally frequency compensated for unity gain
- Large DC voltage gain — 100dB
- Wide bandwidth (unity gain) (temperature compensated) — 1MHz
- Wide power supply range:
  - Single supply — 3V to 30V
  - or dual supplies — ±1.5V to ±15V
- Very low supply current drain (800μA) — essentially independent of supply voltage (1mW/op amp at +5V)
- Low input biasing current (temperature compensated) — 45nA
- Low input offset — 2mV
  and offset current — 5nA
- Input common-mode voltage range includes ground
- Differential input voltage range equal to the power supply voltage
- Large output voltage swing — 0V to V⁺ — 1.5V

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GENERAL DESCRIPTION

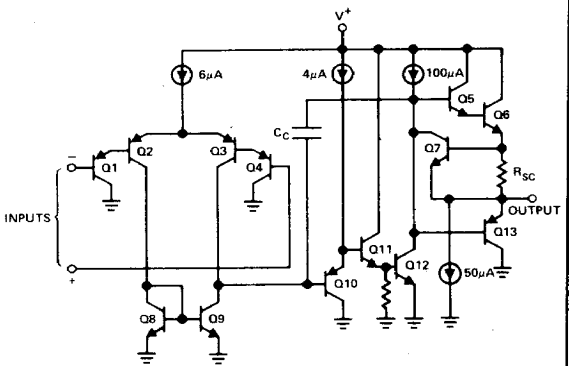
The LM124 series consists of four independent, high gain, internally frequency compensated operational amplifiers which were designed specifically to operate from a single power supply over a wide range of voltages. Operation from split power supplies is also possible and the low power supply current drain is independent of the magnitude of the power supply voltage.

Application areas include transducer amplifiers, dc gain blocks and all the conventional op amp circuits which now can be more easily implemented in single power supply systems. For example, the LM124 series can be directly operated off of the standard +5V power supply voltage which is used in digital systems and will easily provide the required interface electronics without requiring the additional ±15V power supplies.

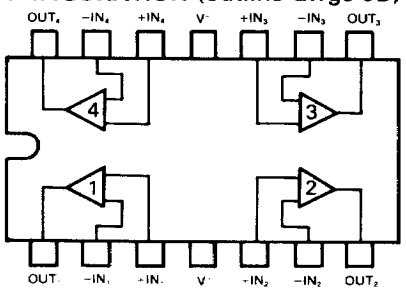
In the linear mode the input common-mode voltage range includes ground, and the output voltage can also swing to ground, even though operated from only a single power supply voltage.

The unity gain cross frequency is temperature compensated, as is the input bias current.

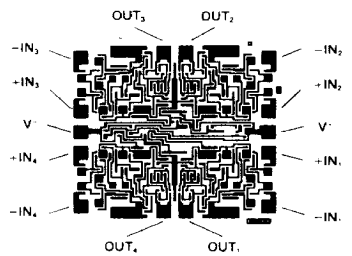
SCHEMATIC DIAGRAM (Each Amplifier)



PIN CONFIGURATION (outline dwgs JD, PD)



CHIP CONFIGURATION



CHIP DIMENSION 56 x 61 MILS

ORDERING INFORMATION

Part Number	Temperature Range	Dice	14 Pin CERDIP	14 Pin Plastic Dip
LM124 LM324	−55°C to +125°C 0°C to +70°C	LM124/D LM324/D	LM124J* LM324J	LM324 N−14

* Add /883B to order number if 883B processing is desired.

ABSOLUTE MAXIMUM RATINGS

Supply Voltage, V^-	32V or ±16V	Input Current ($V_{IN} < -0.3\ V_{OL}$), (Note 3)	50 mA
Differential Input Voltage	32V	Operating Temperature Range	
Input Voltage	−0.3V to +32V	LM324	0°C to +70°C
Power Dissipation (Note 1)		LM124	−55°C to +125°C
Plastic	570 mW	Storage Temperature Range	−65°C to +150°C
CERDIP	900 mW	Lead Temperature (Soldering, 10 seconds)	300°C
Output Short-Circuit to GND (One Amplifier) (Note 2) $V^- \le 15$ and $T_A = 25°C$	Continuous		

Stresses above 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 above those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS ($V^+ = +5.0V$, Note 4)

PARAMETER	CONDITIONS	LM124 MIN	LM124 TYP	LM124 MAX	LM324 MIN	LM324 TYP	LM324 MAX	UNITS
Input Offset Voltage	$T_A = 25°C$, (Note 5)		±2	±5		±2	±7	mV
Input Bias Current (Note 6)	$I_{IN(+)}$ or $I_{IN(-)}$ $T_A = 25°C$		45	150		45	250	nA
Input Offset Current	$I_{IN(+)} - I_{IN(-)}$, $T_A = 25°C$		±3	±30		±5	±50	nA
Input Common-Mode Voltage Range (Note 7)	$V^- = 30V$, $T_A = 25°C$	0		$V^+ - 1.5$	0		$V^+ - 1.5$	V
Supply Current	$R_L = \infty$ $V_{CC} = 30V$, (LM2902 $V_{CC} = 26C$)		1.5	3		1.5	3	mA
	$R_L = \infty$ On All Op Amps		0.7	1.2		0.7	1.2	mA
	Over Full Temperature Range $T_A = 25°C$							mA
Large Signal Voltage Gain	$V^+ = 15V$ (For Large V_O Swing) $R_L \ge 2k\Omega$, $T_A = 25°C$	50	100		25	100		V/mV
Output Voltage Swing	$R_L = 2k\Omega$, $T_A = 25°C$ (LM2902 $R_L \ge 10k\Omega$)	0		$V^+ - 1.5$	0		$V^+ - 1.5$	V
Common-Mode Rejection Ratio	DC, $T_A = 25°C$	70	85		65	70		dB
Power Supply Rejection Ratio	DC, $T_A = 25°C$	65	100		65	100		dB
Amplifier-to-Amplifier Coupling (Note 8)	f = 1kHz to 20kHz, $T_A = 25°C$ (Input Referred)		−120			−120		dB
Output Current Source	$V_{IN^+} = 1V$, $V_{IN^-} = 0V$, $V^+ = 15V$, $T_A = 25°C$	20	40		20	40		mA
Sink	$V_{IN^-} = 1V$, $V_{IN^+} = 0V$, $V^- = 15V$, $T_A = 25°C$	10	20		10	20		mA
	$V_{IN^-} = 1V$, $V_{IN^+} = 0V$, $T_A = 25°C$, $V_O = 200mV$	12	50		12	50		µA
Short Circuit to Ground	$T_A = 25°C$, (Note 2)		40	60		40	60	mA
Short Circuit to V^+			20	40		20	40	
Input Offset Voltage	(Note 5)			±7			±9	mV
Input Offset Voltage Drift	$R_S = 0\Omega$		7			7		µV/°C
Input Offset Current	$I_{IN(+)} - I_{IN(-)}$			±100			±150	nA
Input Offset Current Drift			10			10		pA/°C
Input Bias Current	$I_{IN(+)}$ or $I_{IN(-)}$		40	500		40	500	nA
Input Common-Mode Voltage Range (Note 7)	$V^+ = 30V$	0		$V^+ - 2$	0		$V^+ - 2$	V
Large Signal Voltage Gain	$V^+ = +15V$ (For Large V_O Swing) $R_L \ge 2k\Omega$	25			15			V/mV
Output Voltage Swing V_{OH}	$V^+ = 30V$, $R_L = 2k\Omega$	26			26			V
	$R_L \ge 10k\Omega$	27	28		27	28		V
V_{OL}	$V^- = 5V$, $R_L \le 10k\Omega$		5	20		5	20	mV
Output Current Source	$V_{IN} = +1V$, $V_{IN^-} = 0V$, $V^+ = 15V$	10	20		10	20		mA
Sink	$V_{IN^-} = +1V$, $V_{IN^+} = 0V$, $V^- = 15V$	5	8		5	8		mA
Differential Input Voltage	(Note 7)			V^-			V^+	V

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Note 1: For operating at high temperatures, the LM324 must be derated based on a +125°C maximum junction temperature and a thermal resistance of 175°C/W which applies for the device soldered in a printed circuit board, operating in a still air ambient. The LM124 can be derated based on a +150°C maximum junction temperature. The dissipation is the total of all four amplifiers—use external resistors, where possible, to allow the amplifier to saturate or to reduce the power which is dissipated in the integrated circuit.

Note 2: Intersil's LM124 series is protected against shorts to either V^+ or V^-. No more than one output at a time should be shorted. At $V_{SUPP} > 15V$, continuous shorts can exceed the power dissipation ratings and cause eventual destruction.

Note 3: This input current will only exist when the voltage at any of the input leads is driven negative. It is due to the collector-base junction of the input PNP transistors becoming forward biased and thereby acting as input diode clamps. In addition to this diode action, there is also lateral NPN parsitic transistor action on the IC chip. This transistor action can cause the output voltages of the op amps to go to the V^+ voltage level (or to ground for a large overdrive) for the time duration that an input is driven negative. This is not destructive and normal output states will re-establish when the input voltage, which was negative again returns to a value greater than −0.3V.

Note 4: These specifications apply for $V^+ = +5V$ and $-55°C \leq T_A \leq +125°C$ for the LM124, and $0°C \leq T_A \leq +70°C$ for the LM324.

Note 5: $V_O \cong 1.4V$, $R_S = 0\Omega$ with V^+ from 5V to 30V, and over the full input common-mode range (0V to $V^+ - 1.5V$).

Note 6: The direction of the input current is out of the IC due to the PNP input stage. This current is essentially constant, independent of the state of the output so no loading change exists on the input lines.

Note 7: The input common-mode voltage or either input signal voltage should not be allowed to go negative by more than 0.3V. The upper end of the common-mode voltage range is $V^+ - 1.5V$, but either or both inputs can go to +32V without damage.

Note 8: Due to proximity of external components, insure that coupling is not originating via stray capacitance between these external parts. This typically can be detected as this type of capacitive coupling increases at higher frequencies.

TYPICAL PERFORMANCE CHARACTERISTICS

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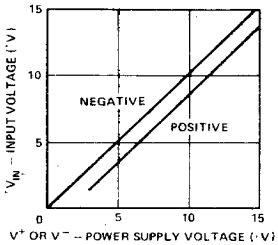
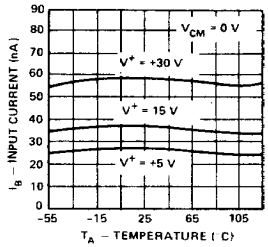
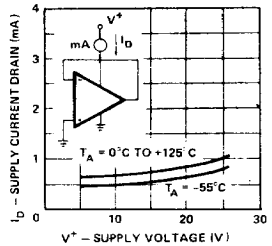
INPUT VOLTAGE RANGE



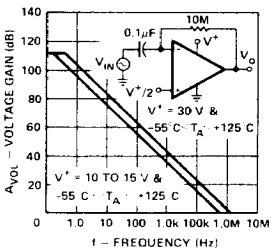
INPUT CURRENT



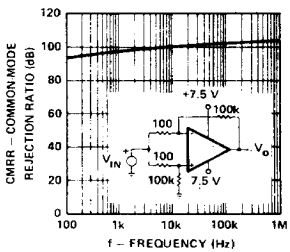
SUPPLY CURRENT



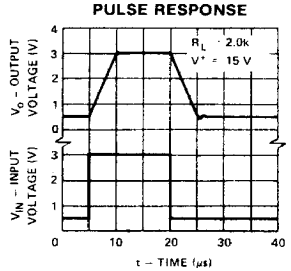
OPEN LOOP FREQUENCY RESPONSE



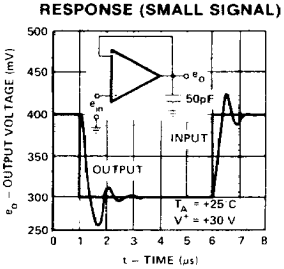
COMMON MODE REJECTION RATIO



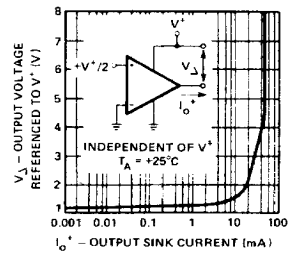
VOLTAGE FOLLOWER PULSE RESPONSE



VOLTAGE FOLLOWER PULSE RESPONSE (SMALL SIGNAL)



OUTPUT CHARACTERISTICS CURRENT SOURCING



OUTPUT CHARACTERISTICS CURRENT SINKING