LM224A-LM324A

Low power quad operational amplifiers

Features

- Wide gain bandwidth: 1.3 MHz
- Input common-mode voltage range includes ground
- Large voltage gain: 100 dB
- Very low supply current/amplifier: 375 µA
- Low input bias current: 20 nA
- Low input offset voltage: 3 mV max.
- Low input offset current: 2 nA
- Wide power supply range:
  Single supply: +3 V to +30 V
  Dual supplies: ±1.5 V to ±15 V

N
DIP14
(Plastic package)

D
SO-14
(Plastic micropackage)

P
TSSOP-14
(Thin shrink small outline package)

Description

These circuits consist of four independent, high gain, internally frequency compensated operational amplifiers. They 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.

Order codes

Part number	Temperature range	Package	Packaging
LM224AN	-40° C, +105° C	DIP	Tube
LM224AD/ADT		SO	Tube or tape & reel
LM224APT		TSSOP (Thin shrink outline package)	Tape & reel
LM324AN	0° C, +70° C	DIP	Tube
LM324AD/ADT		SO	Tube or tape & reel
LM324APT		TSSOP (Thin shrink outline package)	Tape & reel

2 Absolute maximum ratings

Table 1. Absolute maximum ratings

Symbol	Parameter	LM224A	LM324A	Unit
V_{CC}	Supply voltage	±16 or 32		V
V_i	Input voltage	-0.3 to V_{CC} + 0.3		V
V_{id}	Differential input voltage (1)	32		V
P_{tot}	Power dissipation: N suffix D suffix	 500 400	 500 400	mW
	Output short-circuit duration (2)	Infinite		
I_{in}	Input current (3)	50		mA
T_{oper}	Operating free-air temperature range	-40 to +105	0 to +70	°C
T_{stg}	Storage temperature range	-65 to +150		°C
T_j	Maximum junction temperature	150		°C
R_{thja}	Thermal resistance junction to ambient(4): SO14 TSSOP14 DIP14	 103 100 83		°C/W
R_{thjc}	Thermal resistance junction to case: SO14 TSSOP14 DIP14	 31 32 33		°C/W
ESD	HBM: human body model(5)	700		V
	MM: machine model(6)	150		
	CDM: charged device model	1500		

1. Neither of the input voltages must exceed the magnitude of V_{CC}^+ or V_{CC}^-.
2. Short-circuits from the output to V_{CC} can cause excessive heating if V_{CC} > 15 V. The maximum output current is approximately 40 mA independent of the magnitude of V_{CC}. Destructive dissipation can result from simultaneous short-circuits on all amplifiers.
3. This input current only exists when the voltage at any of the input leads is driven negative. It is due to the collector-base junction of the input PNP transistor becoming forward biased and thereby acting as input diode clamps. In addition to this diode action, there is also NPN parasitic action on the IC chip. This transistor action can cause the output voltages of the op-amps to go to the V_{CC} voltage level (or to ground for a large overdrive) for the time during which an input is driven negative.
This is not destructive and normal output will set up again for input voltage higher than -0.3 V.
4. Short-circuits can cause excessive heating. Destructive dissipation can result from simultaneous short-circuits on all amplifiers. These are typical values given for a single layer board (except for TSSOP which is a two-layer board).
5. Human body model, 100 pF discharged through a 1.5 kΩ resistor into pin of device.
6. Machine model ESD, a 200 pF cap is charged to the specified voltage, then discharged directly into the IC with no external series resistor (internal resistor < 5Ω), into pin-to-pin of device.

3 Electrical characteristics

Table 2. V_{CC}^+ = +5V, V_{CC}^-= Ground, V_o = 1.4V, T_{amb} = +25°C (unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Unit
V_{io}	Input offset voltage (1): T_{amb} = +25° C $T_{min} \le T_{amb} \le T_{max}$		2	3 5	mV
I_{io}	Input offset current: T_{amb} = +25° C $T_{min} \le T_{amb} \le T_{max}$		2	20 40	nA
I_{ib}	Input bias current (2): T_{amb} = +25° C $T_{min} \le T_{amb} \le T_{max}$		20	100 200	nA
A_{vd}	Large signal voltage gain: V_{CC}^+ = +15 V, R_L = 2 kΩ, V_o = 1.4 V to 11.4 V T_{amb} = +25° C $T_{min} \le T_{amb} \le T_{max}$	 50 25	 100		V/mV
SVR	Supply voltage rejection ratio ($R_s \le 10$ kΩ): V_{CC}^+ = 5 V to 30 V T_{amb} = +25° C $T_{min} \le T_{amb} \le T_{max}$	 65 65	 110		dB
I_{CC}	Supply current, all Amp, no load: – T_{amb} = +25° C V_{CC} = +5V V_{CC} = +30 V – $T_{min} \le T_{amb} \le T_{max}$ V_{CC} = +5 V V_{CC} = +30 V		 0.7 1.5 0.8 1.5	 1.2 3 1.2 3	mA
V_{icm}	Input common mode voltage range: V_{CC} = +30 V (3) T_{amb} = +25° C $T_{min} \le T_{amb} \le T_{max}$	 0 0		 V_{CC} -1.5 V_{CC} -2	V
CMR	Common mode rejection ratio ($R_s \le 10$ kΩ): T_{amb} = +25° C $T_{min} \le T_{amb} \le T_{max}$	 70 60	 80		dB
I_{source}	Output current source (V_{id} = +1 V): V_{CC} = +15 V, V_o = +2 V	 20	 40	 70	mA
I_{sink}	Output sink current (V_{id} = -1 V): V_{CC} = +15 V, V_o = +2 V V_{CC} = +15 V, V_o = +0.2 V	 10 12	 20 50		mA µA

Table 2. V_{CC}^+ = +5V, V_{CC}^-= Ground, V_o = 1.4V, T_{amb} = +25°C (unless otherwise specified)

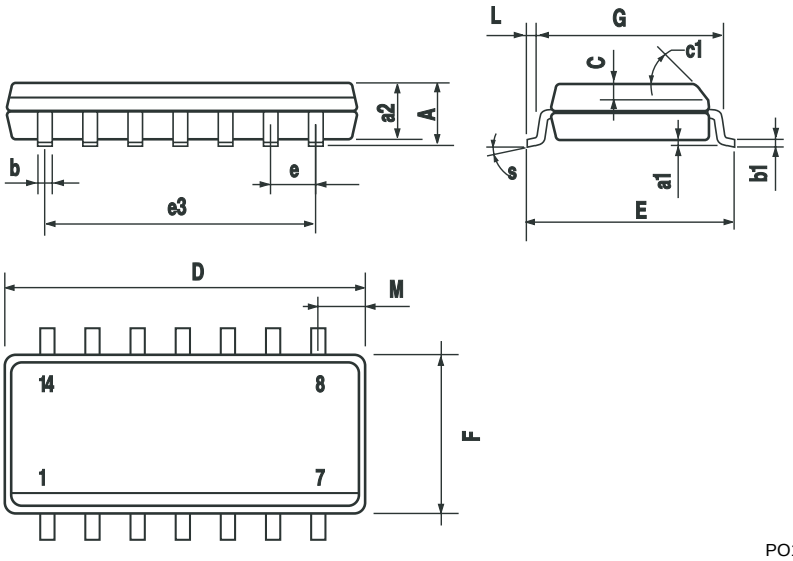
Symbol	Parameter	Min.	Typ.	Max.	Unit
V_{OH}	High level output voltage V_{CC} = +30 V, R_L = 2 kΩ T_{amb} = +25°C $T_{min} \le T_{amb} \le T_{max}$	 26 26	27		V
	V_{CC} = +30 V, R_L = 10 kΩ T_{amb} = +25° C $T_{min} \le T_{amb} \le T_{max}$	 27 27	28		V
	V_{CC} = +5 V, R_L = 2 kΩ T_{amb} = +25° C $T_{min} \le T_{amb} \le T_{max}$	 3.5 3			V
V_{OL}	Low level output voltage (R_L = 10kΩ): T_{amb} = +25°C $T_{min} \le T_{amb} \le T_{max}$		5	 20 20	mV
SR	Slew rate: V_{CC} = 15 V, V_i = 0.5 to 3 V, R_L = 2 kΩ, C_L = 100 pF, unity gain		0.4		V/µs
GBP	Gain bandwidth product: V_{CC} = 30 V, f =100 kHz, V_{in} = 10 mV, R_L = 2 kΩ, C_L = 100pF		1.3		MHz
THD	Total harmonic distortion: f = 1kHz, A_v = 20dB, R_L = 2kΩ, V_o = $2V_{pp}$, C_L = 100pF, V_{CC} = 30V		0.015		%
e_n	Equivalent input noise voltage: f = 1 kHz, R_s = 100 Ω, V_{CC} = 30 V		40		$\frac{nV}{\sqrt{Hz}}$
DV_{io}	Input offset voltage drift		7	30	µV/°C
DI_{io}	Input offset current drift		10	200	pA/°C
V_{o1}/V_{o2}	Channel separation(4) - 1kHz ≤ f ≤ 20 kHZ		120		dB

1. V_o = 1.4 V, R_s = 0 Ω, 5 V < V_{CC}^+ < 30 V, 0 < V_{ic} < V_{CC}^+ - 1.5 V
2. The direction of the input current is out of the IC. This current is essentially constant, independent of the state of the output so there is no load change on the input lines.
3. The input common-mode voltage of either input signal voltage should not be allowed to go negative by more than 0.3 V. The upper end of the common-mode voltage range is V_{CC}^+ - 1.5 V, but either or both inputs can go to +32 V without damage.
4. Due to the proximity of external components, ensure that there is no coupling originating from stray capacitance between these external parts. Typically, this can be detected at higher frequencies because this type of capacitance increases.

6.2 SO-14 package

SO-14 MECHANICAL DATA

DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A			1.75			0.068
a1	0.1		0.2	0.003		0.007
a2			1.65			0.064
b	0.35		0.46	0.013		0.018
b1	0.19		0.25	0.007		0.010
C		0.5			0.019	
c1	45° (typ.)					
D	8.55		8.75	0.336		0.344
E	5.8		6.2	0.228		0.244
e		1.27			0.050	
e3		7.62			0.300	
F	3.8		4.0	0.149		0.157
G	4.6		5.3	0.181		0.208
L	0.5		1.27	0.019		0.050
M			0.68			0.026
S	8° (max.)					



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