

LM2902, LM324/LM324A, LM224/ LM224A

Quad Operational Amplifier

Features

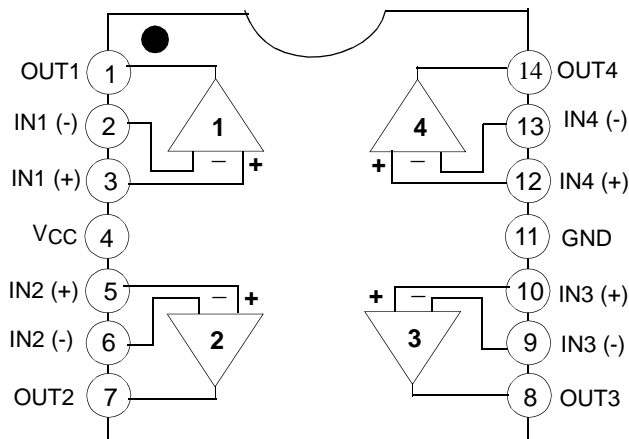
- Internally Frequency Compensated for Unity Gain
- Large DC Voltage Gain: 100dB
- Wide Power Supply Range:
LM224/LM224A, LM324/LM324A : 3V~32V (or $\pm 1.5 \sim 16V$)
LM2902: 3V~26V (or $\pm 1.5V \sim 13V$)
- Input Common Mode Voltage Range Includes Ground
- Large Output Voltage Swing: 0V to $V_{CC} - 1.5V$
- Power Drain Suitable for Battery Operation

Description

The LM324/LM324A, LM2902, LM224/LM224A consist of four independent, high gain, internally frequency compensated operational amplifiers which were designed specifically to operate from a single power supply over a wide voltage range. operation from split power supplies is also possible so long as the difference between the two supplies is 3 volts to 32 volts. Application areas include transducer amplifier, DC gain blocks and all the conventional OP Amp circuits which now can be easily implemented in single power supply systems.

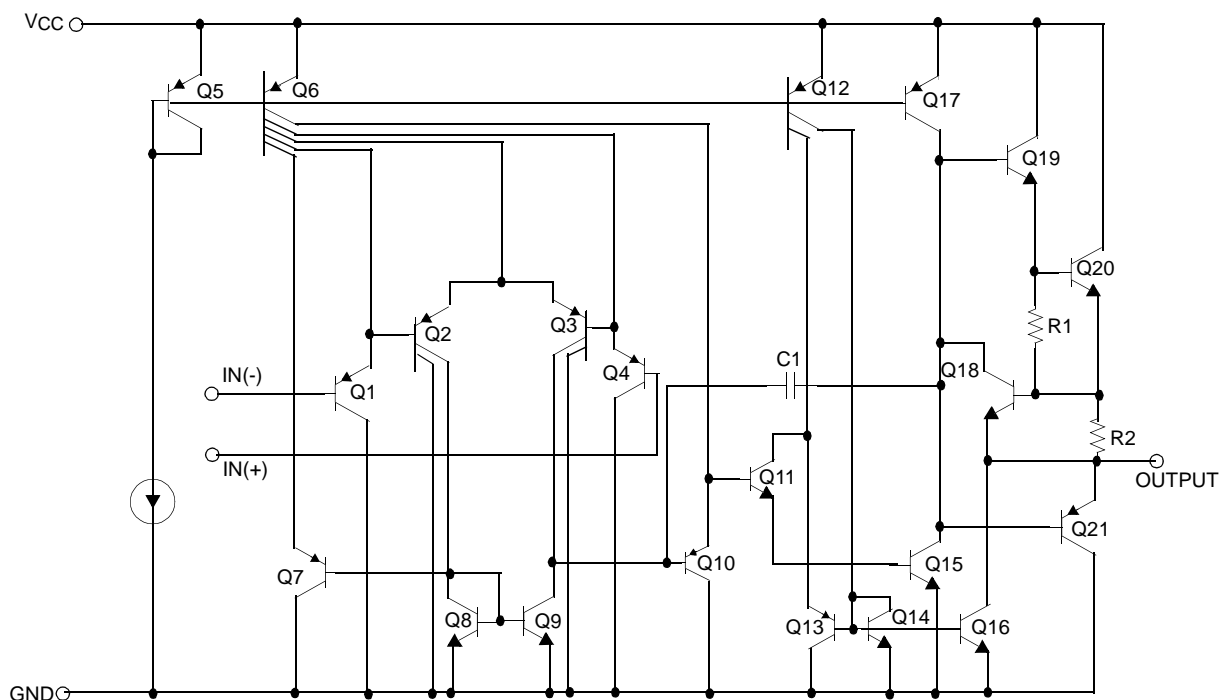


Internal Block Diagram



Schematic Diagram

(One Section Only)



Absolute Maximum Ratings

Parameter	Symbol	LM224/LM224A	LM324/LM324A	LM2902	Unit
Power Supply Voltage	VCC	±16 or 32	±16 or 32	±13 or 26	V
Differential Input Voltage	VI(DIFF)	32	32	26	V
Input Voltage	VI	-0.3 to +32	-0.3 to +32	-0.3 to +26	V
Output Short Circuit to GND Vcc≤15V, TA=25°C(one Amp)	-	Continuous	Continuous	Continuous	-
Power Dissipation, TA=25°C 14-DIP 14-SOP	PD	1310 640	1310 640	1310 640	mW
Operating Temperature Range	TOPR	-25 ~ +85	0 ~ +70	-40 ~ +85	°C
Storage Temperature Range	TSTG	-65 ~ +150	-65 ~ +150	-65 ~ +150	°C

Thermal Data

Parameter	Symbol	Value	Unit
Thermal Resistance Junction-Ambient Max. 14-DIP 14-SOP	Rθja	95 195	°C/W

Electrical Characteristics

($V_{CC} = 5.0V$, $V_{EE} = GND$, $T_A = 25^\circ C$, unless otherwise specified)

Parameter	Symbol	Conditions	LM224			LM324			LM2902			Unit	
			Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.		
Input Offset Voltage	V_{IO}	$V_{CM} = 0V$ to $V_{CC} - 1.5V$ $V_{O(P)} = 1.4V$, $R_S = 0\Omega$ (Note1)	-	1.5	5.0	-	1.5	7.0	-	1.5	7.0	mV	
Input Offset Current	I_{IO}	$V_{CM} = 0V$	-	2.0	30	-	3.0	50	-	3.0	50	nA	
Input Bias Current	I_{BIAS}	$V_{CM} = 0V$	-	40	150	-	40	250	-	40	250	nA	
Input Common-Mode Voltage Range	$V_{I(R)}$	Note1	0	-	$V_{CC} - 1.5$	0	$V_{CC} - 1.5$	-	0	-	$V_{CC} - 1.5$	V	
Supply Current	I_{CC}	$R_L = \infty$, $V_{CC} = 30V$ (LM2902, $V_{CC} = 26V$)	-	1.0	3	-	1.0	3	-	1.0	3	mA	
		$R_L = \infty$, $V_{CC} = 5V$	-	0.7	1.2	-	0.7	1.2	-	0.7	1.2	mA	
Large Signal Voltage Gain	G_V	$V_{CC} = 15V$, $R_L = 2k\Omega$ $V_{O(P)} = 1V$ to $11V$	50	100	-	25	100	-	25	100	-	V/ mV	
Output Voltage Swing	$V_{O(H)}$	Note1	$R_L = 2k\Omega$	26	-	-	26	-	-	22	-	-	V
			$R_L = 10k\Omega$	27	28	-	27	28	-	23	24	-	V
	$V_{O(L)}$	$V_{CC} = 5V$, $R_L = 10k\Omega$	-	5	20	-	5	20	-	5	100	mV	
Common-Mode Rejection Ratio	CMRR	-	70	85	-	65	75	-	50	75	-	dB	
Power Supply Rejection Ratio	PSRR	-	65	100	-	65	100	-	50	100	-	dB	
Channel Separation	CS	$f = 1kHz$ to $20kHz$ (Note2)	-	120	-	-	120	-	-	120	-	dB	
Short Circuit to GND	I_{SC}	$V_{CC} = 15V$	-	40	60	-	40	60	-	40	60	mA	
Output Current	I_{SOURCE}	$V_{I(+)} = 1V$, $V_{I(-)} = 0V$ $V_{CC} = 15V$ $V_{O(P)} = 2V$	20	40	-	20	40	-	20	40	-	mA	
		$V_{I(+)} = 0V$, $V_{I(-)} = 1V$ $V_{CC} = 15V$ $V_{O(P)} = 2V$	10	13	-	10	13	-	10	13	-	mA	
	I_{SINK}	$V_{I(+)} = 0V$, $V_{I(-)} = 1V$ $V_{CC} = 5V$, $V_{O(R)} = 200mV$	12	45	-	12	45	-	-	-	-	μA	
Differential Input Voltage	$V_{I(DIFF)}$	-	-	V_{CC}	-	-	V_{CC}	-	-	V_{CC}	V		

Note :

- $V_{CC} = 30V$ for LM224 and LM324, $V_{CC} = 26V$ for LM2902
- This parameter, although guaranteed, is not 100% tested in production.

Electrical Characteristics (Continued)

(VCC = 5.0V, VEE = GND, unless otherwise specified)

The following specifications apply over the range of $-25^{\circ}\text{C} \leq T_A \leq +85^{\circ}\text{C}$ for the LM224; and the $0^{\circ}\text{C} \leq T_A \leq +70^{\circ}\text{C}$ for the LM324; and the $-40^{\circ}\text{C} \leq T_A \leq +85^{\circ}\text{C}$ for the LM2902

Parameter	Symbol	Conditions	LM224			LM324			LM2902			Unit	
			Min.	Typ.	Max.	Min.	Typ.	Max.	Min.	Typ.	Max.		
Input Offset Voltage	V _{IO}	V _{ICM} = 0V to V _{CC} -1.5V V _{O(P)} = 1.4V, R _S = 0Ω (Note1)	-	-	7.0	-	-	9.0	-	-	10.0	mV	
Input Offset Voltage Drift	ΔV _{IO} /ΔT	R _S = 0Ω (Note2)	-	7.0	-	-	7.0	-	-	7.0	-	μV/°C	
Input Offset Current	I _{IO}	V _{CM} = 0V	-	-	100	-	-	150	-	-	200	nA	
Input Offset Current Drift	ΔI _{IO} /ΔT	R _S = 0Ω (Note2)	-	10	-	-	10	-	-	10	-	pA/°C	
Input Bias Current	I _{BIAS}	V _{CM} = 0V	-	-	300	-	-	500	-	-	500	nA	
Input Common-Mode Voltage Range	V _{I(R)}	Note1	0	-	V _{CC} -2.0	0	-	V _{CC} -2.0	0	-	V _{CC} -2.0	V	
Large Signal Voltage Gain	G _V	V _{CC} = 15V, R _L = 2.0kΩ V _{O(P)} = 1V to 11V	25	-	-	15	-	-	15	-	-	V/mV	
Output Voltage Swing	V _{O(H)}	Note1	R _L =2kΩ	26	-	-	26	-	-	22	-	-	V
			R _L =10kΩ	27	28	-	27	28	-	23	24	-	V
	V _{O(L)}	V _{CC} = 5V, R _L =10kΩ	-	5	20	-	5	20	-	5	100	mV	
Output Current	I _{SOURCE}	V _{I(+)} = 1V, V _{I(-)} = 0V V _{CC} = 15V, V _{O(P)} = 2V	10	20	-	10	20	-	10	20	-	mA	
	I _{SINK}	V _{I(+)} = 0V, V _{I(-)} = 1V V _{CC} = 15V, V _{O(P)} = 2V	10	13	-	5	8	-	5	8	-	mA	
Differential Input Voltage	V _{I(DIFF)}	-	-	-	V _{CC}	-	-	V _{CC}	-	-	V _{CC}	V	

Note:

1. V_{CC}=30V for LM224 and LM324, V_{CC} = 26V for LM2902
2. These parameters, although guaranteed, are not 100% tested in production.

Electrical Characteristics (Continued)(V_{CC} = 5.0V, V_{EE} = GND, T_A = 25°C, unless otherwise specified)

Parameter	Symbol	Conditions	LM224A			LM324A			Unit	
			Min.	Typ.	Max.	Min.	Typ.	Max.		
Input Offset Voltage	V _{IO}	V _{CM} = 0V to V _{CC} -1.5V V _{O(P)} = 1.4V, R _S = 0Ω (Note1)	-	1.0	3.0	-	1.5	3.0	mV	
Input Offset Current	I _{IO}	V _{CM} = 0V	-	2	15	-	3.0	30	nA	
Input Bias Current	I _{BIAS}	V _{CM} = 0V	-	40	80	-	40	100	nA	
Input Common-Mode Voltage Range	V _{I(R)}	V _{CC} = 30V	0	-	V _{CC} -1.5	0	-	V _{CC} -1.5	V	
Supply Current	I _{CC}	V _{CC} = 30V, R _L = ∞	-	1.5	3	-	1.5	3	mA	
		V _{CC} = 5V, R _L = ∞	-	0.7	1.2	-	0.7	1.2	mA	
Large Signal Voltage Gain	G _V	V _{CC} = 15V, R _L = 2kΩ V _{O(P)} = 1V to 11V	50	100	-	25	100	-	V/mV	
Output Voltage Swing	V _{O(H)}	Note1	R _L = 2kΩ	26	-	-	26	-	-	V
			R _L = 10kΩ	27	28	-	27	28	-	V
	V _{O(L)}	V _{CC} = 5V, R _L = 10kΩ	-	5	20	-	5	20	mV	
Common-Mode Rejection Ratio	CMRR	-	70	85	-	65	85	-	dB	
Power Supply Rejection Ratio	PSRR	-	65	100	-	65	100	-	dB	
Channel Separation	CS	f = 1kHz to 20kHz (Note2)	-	120	-	-	120	-	dB	
Short Circuit to GND	I _{SC}	V _{CC} = 15V	-	40	60	-	40	60	mA	
Output Current	I _{SOURCE}	V _{I(+)} = 1V, V _{I(-)} = 0V V _{CC} = 15V, V _{O(P)} = 2V	20	40	-	20	40	-	mA	
		V _{I(+)} = 0V, V _{I(-)} = 1V V _{CC} = 15V, V _{O(P)} = 2V	10	20	-	10	20	-	mA	
	I _{SINK}	V _{I(+)} = 0V, V _{I(-)} = 1V V _{CC} = 5V V _{O(P)} = 200mV	12	50	-	12	50	-	μA	
Differential Input Voltage	V _{I(DIFF)}	-	-	-	V _{CC}	-	-	V _{CC}	V	

Note:

- V_{CC} = 30V for LM224A, LM324A
- This parameter, although guaranteed, is not 100% tested in production.

Electrical Characteristics (Continued)

(VCC = 5.0V, VEE = GND, unless otherwise specified)

The following specification apply over the range of $-25^{\circ}\text{C} \leq T_A \leq +85^{\circ}\text{C}$ for the LM224A; and the $0^{\circ}\text{C} \leq T_A \leq +70^{\circ}\text{C}$ for the LM324A

Parameter	Symbol	Conditions	LM224A			LM324A			Unit	
			Min.	Typ.	Max.	Min.	Typ.	Max.		
Input Offset Voltage	V _{IO}	V _{CM} = 0V to V _{CC} -1.5V V _{O(P)} = 1.4V, R _S = 0Ω (Note1)	-	-	4.0	-	-	5.0	mV	
Input Offset Voltage Drift	ΔV _{IO} /ΔT	R _S = 0Ω (Note2)	-	7.0	20	-	7.0	30	μV/°C	
Input Offset Current	I _{IO}	V _{CM} = 0V	-	-	30	-	-	75	nA	
Input Offset Current Drift	ΔI _{IO} /ΔT	R _S = 0Ω (Note2)	-	10	200	-	10	300	pA/°C	
Input Bias Current	I _{BIAS}	-	-	40	100	-	40	200	nA	
Input Common-Mode Voltage Range	V _{I(R)}	Note1	0	-	V _{CC} -2.0	0	-	V _{CC} -2.0	V	
Large Signal Voltage Gain	G _V	V _{CC} = 15V, R _L = 2.0kΩ	25	-	-	15	-	-	V/mV	
Output Voltage Swing	V _{O(H)}	Note1	R _L = 2kΩ	26	-	-	26	-	-	V
			R _L = 10kΩ	27	28	-	27	28	-	V
	V _{O(L)}	V _{CC} = 5V, R _L = 10kΩ	-	5	20	-	5	20	mV	
Output Current	I _{SOURCE}	V _{I(+)} = 1V, V _{I(-)} = 0V V _{CC} = 15V, V _{O(P)} = 2V	10	20	-	10	20	-	mA	
	I _{SINK}	V _{I(+)} = 0V, V _{I(-)} = 1V V _{CC} = 15V, V _{O(P)} = 2V	5	8	-	5	8	-	mA	
Differential Input Voltage	V _{I(DIFF)}	-	-	-	V _{CC}	-	-	V _{CC}	V	

Note:

1. V_{CC} = 30V for LM224A and LM324A.
2. These parameters, although guaranteed, are not 100% tested in production.

Typical Performance Characteristics (Continued)

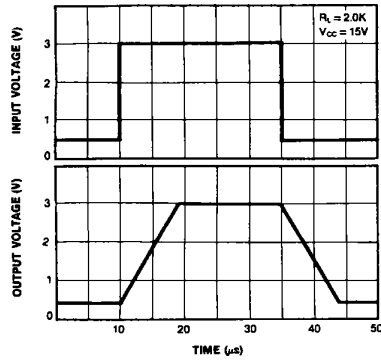


Figure 7. Voltage Follower Pulse Response

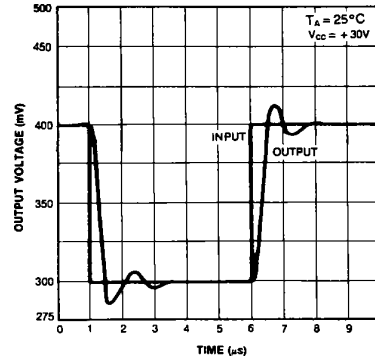


Figure 8. Voltage Follower Pulse Response (Small Signal)

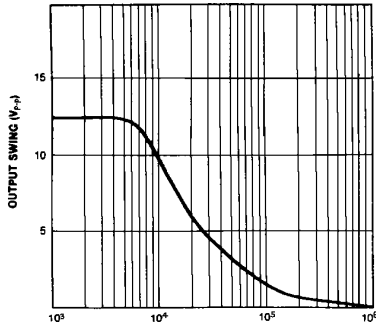


Figure 8. Large Signal Frequency Response

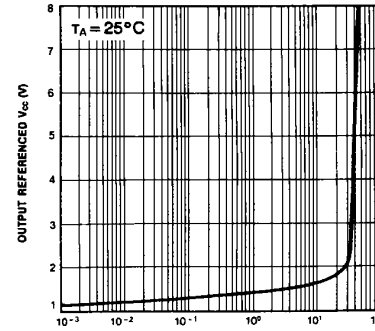


Figure 9. Output Characteristics vs Current Sourcing

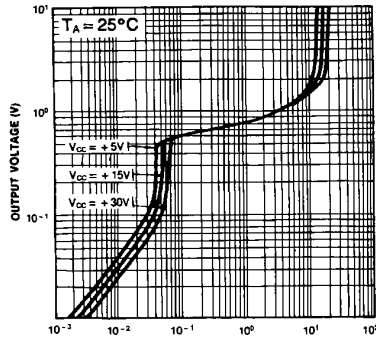


Figure 10. Output Characteristics vs Current Sinking

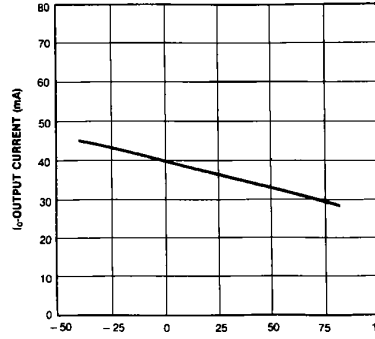


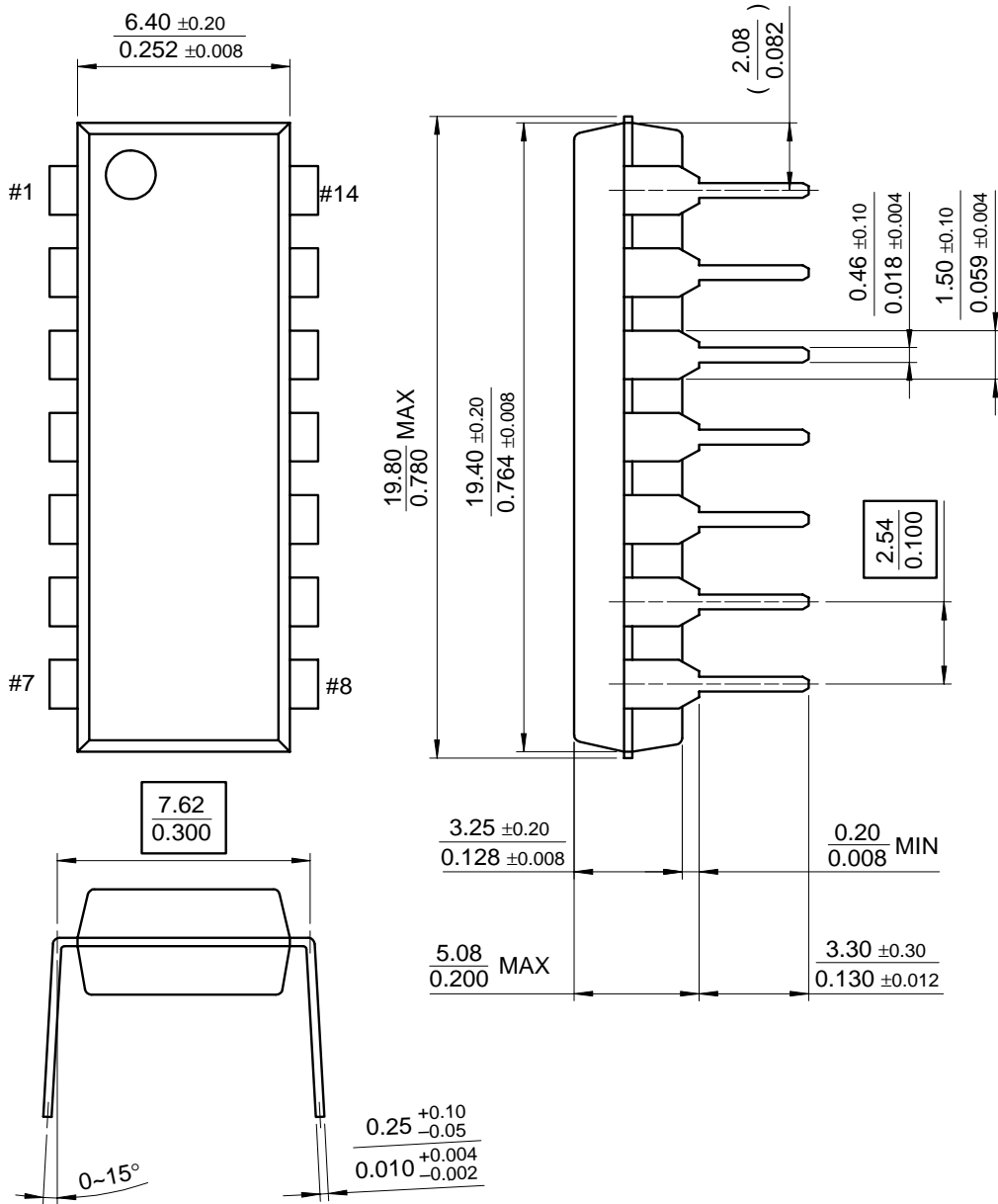
Figure 11. Current Limiting vs Temperature

Mechanical Dimensions

Package

Dimensions in millimeters

14-DIP

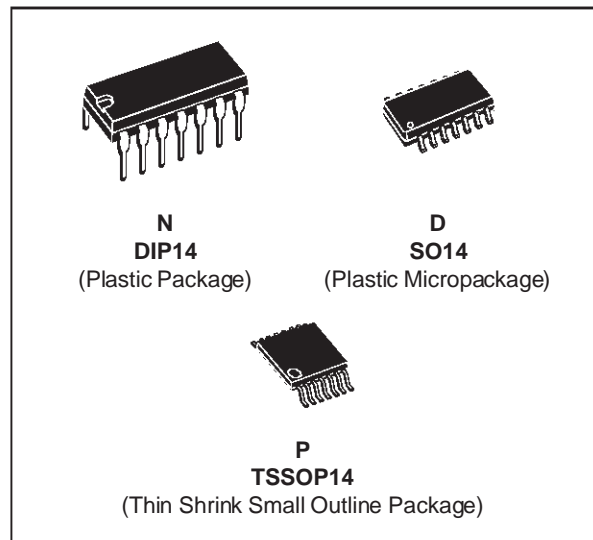




LM124 LM224 - LM324

LOW POWER QUAD OPERATIONAL AMPLIFIERS

- WIDE GAIN BANDWIDTH : 1.3MHz
- INPUT COMMON-MODE VOLTAGE RANGE INCLUDES GROUND
- LARGE VOLTAGE GAIN : 100dB
- VERY LOW SUPPLY CURRENT/AMPLI : 375 μ A
- LOW INPUT BIAS CURRENT : 20nA
- LOW INPUT OFFSET VOLTAGE : 5mV max.
(for more accurate applications, use the equivalent parts LM124A-LM224A-LM324A which feature 3mV max)
- LOW INPUT OFFSET CURRENT : 2nA
- WIDE POWER SUPPLY RANGE :
SINGLE SUPPLY : +3V TO +30V
DUAL SUPPLIES : \pm 1.5V TO \pm 15V



DESCRIPTION

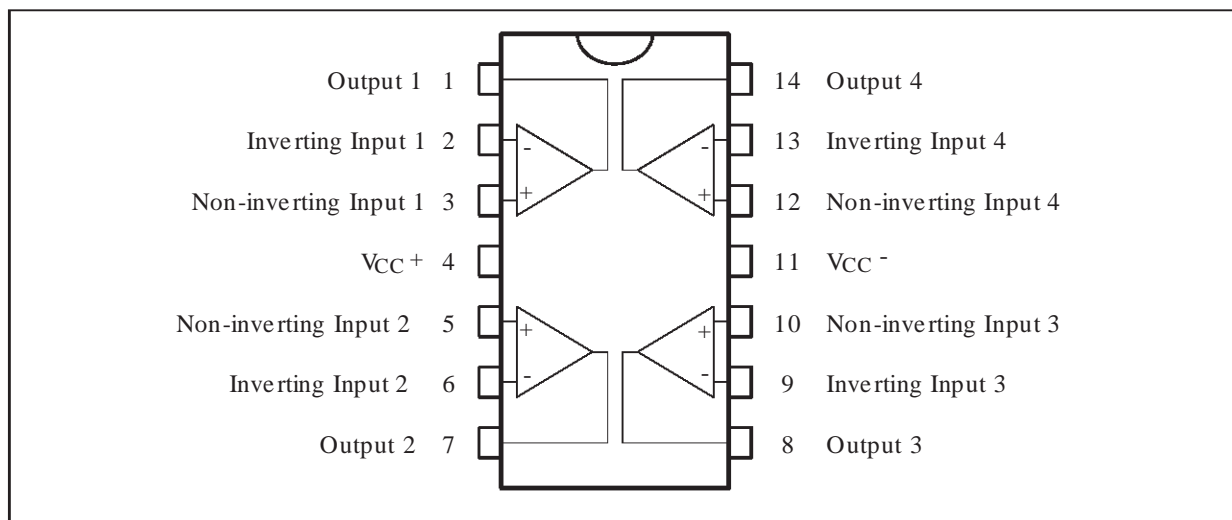
These circuits consist of four independent, high gain, internally frequency compensated operational amplifiers. They operate from a single power supply over a wide range of voltages. Operation from split power supplies is also possible and the low power supply current drain is independent of the magnitude of the power supply voltage.

ORDER CODES

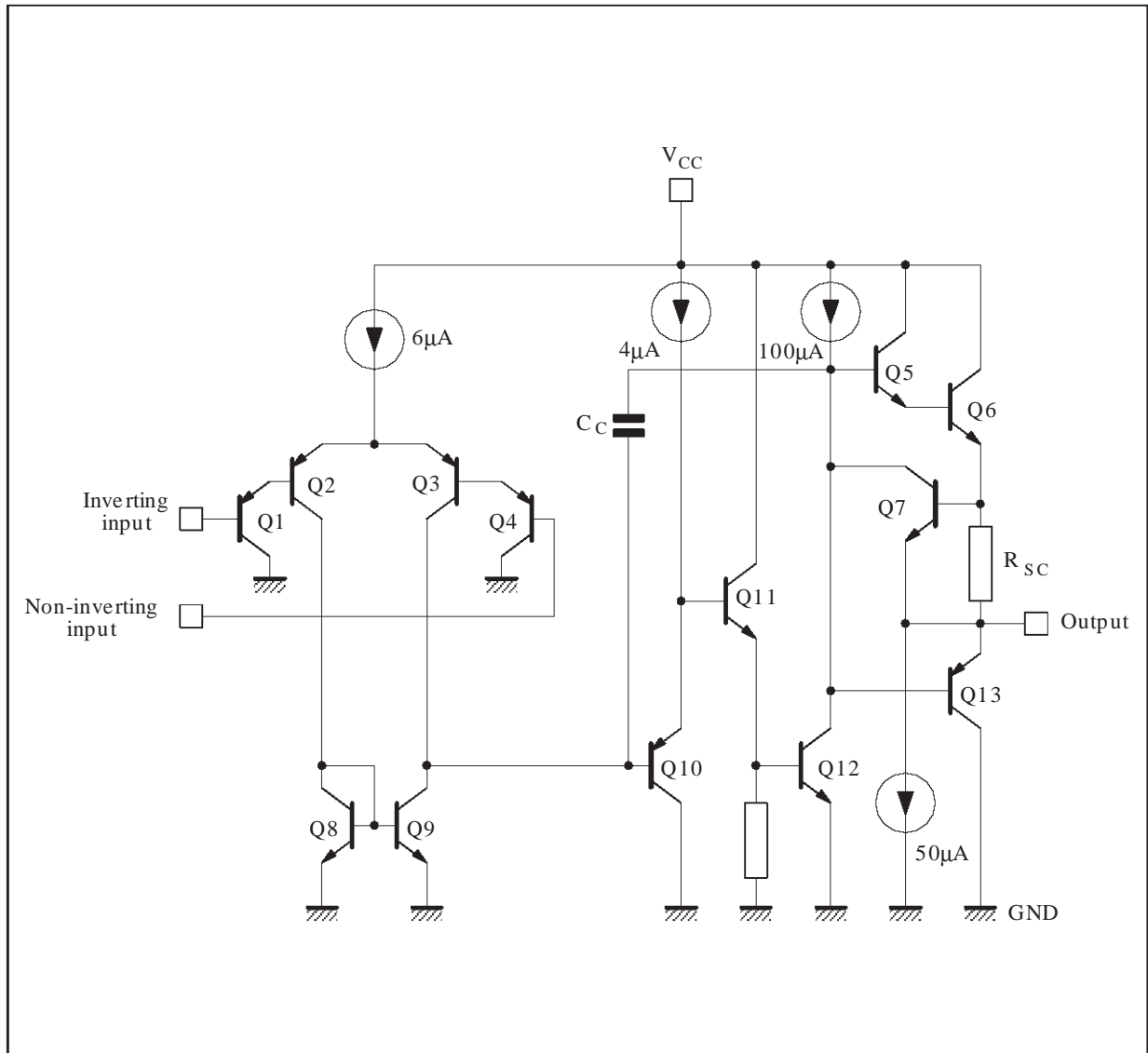
Part Number	Temperature Range	Package		
		N	D	P
LM124	-55°C, +125°C	•	•	•
LM224	-40°C, +105°C	•	•	•
LM324	0°C, +70°C	•	•	•

Example : LM224N

PIN CONNECTIONS (top view)



SCHMATIC DIAGRAM (1/4 LM124)



ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	LM124	LM224	LM324	Unit
V_{cc}	Supply Voltage	±16 or 32			V
V_i	Input Voltage	-0.3 to +32			V
V_{id}	Differential Input Voltage - (*)	+32	+32	+32	V
P_{tot}	Power Dissipation	500	500	500	mW
		-	400	400	mW
-	Output Short-circuit Duration - (note 1)	Infinite			
I_{in}	Input Current - (note 6)	50	50	50	mA
T_{oper}	Operating Free Air Temperature Range	-55 to +125	-40 to +105	0 to +70	°C
T_{stg}	Storage Temperature Range	-65 to +150	-65 to +150	-65 to +150	°C

ELECTRICAL CHARACTERISTICS

$V_{CC}^+ = +5V$, $V_{CC}^- = \text{Ground}$, $V_O = 1.4V$, $T_{amb} = +25^\circ C$ (unless otherwise specified)

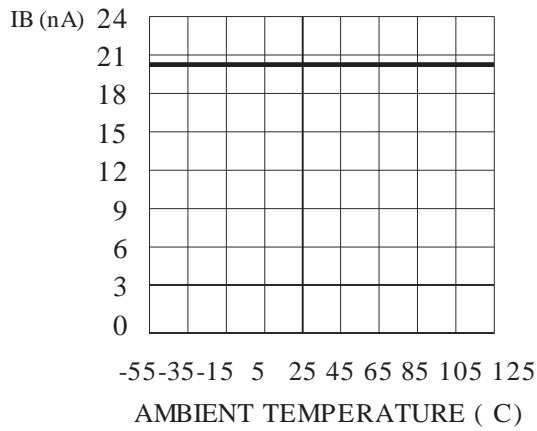
Symbol	Parameter	LM124 - LM224 - LM324			Unit
		Min.	Typ.	Max.	
V_{io}	Input Offset Voltage (note 3) $T_{amb} = +25^\circ C$ LM324 $T_{min.} \leq T_{amb} \leq T_{max.}$ LM324		2	5 7 7 9	mV
I_{io}	Input Offset Current $T_{amb} = +25^\circ C$ $T_{min.} \leq T_{amb} \leq T_{max.}$		2	30 100	nA
I_{ib}	Input Bias Current (note 2) $T_{amb} = +25^\circ C$ $T_{min.} \leq T_{amb} \leq T_{max.}$		20	150 300	nA
A_{vd}	Large Signal Voltage Gain ($V_{CC}^+ = +15V$, $R_L = 2k\Omega$, $V_O = 1.4V$ to $11.4V$) $T_{amb} = +25^\circ C$ $T_{min.} \leq T_{amb} \leq T_{max.}$	50 25	100		V/mV
SVR	Supply Voltage Rejection Ratio ($R_S \leq 10k\Omega$) ($V_{CC}^+ = 5V$ to $30V$) $T_{amb} = +25^\circ C$ $T_{min.} \leq T_{amb} \leq T_{max.}$	65 65	110		dB
I_{CC}	Supply Current, all Amp, no load $T_{amb} = +25^\circ C$ $T_{min.} \leq T_{amb} \leq T_{max.}$ $V_{CC} = +5V$ $V_{CC} = +30V$ $V_{CC} = +5V$ $V_{CC} = +30V$		0.7 1.5 0.8 1.5	1.2 3 1.2 3	mA
V_{icm}	Input Common Mode Voltage Range ($V_{CC} = +30V$) - (note 4) $T_{amb} = +25^\circ C$ $T_{min.} \leq T_{amb} \leq T_{max.}$	0 0		$V_{CC} - 1.5$ $V_{CC} - 2$	V
CMR	Common-mode Rejection Ratio ($R_S \leq 10k\Omega$) $T_{amb} = +25^\circ C$ $T_{min.} \leq T_{amb} \leq T_{max.}$	70 60	80		dB
I_{source}	Output Current Source ($V_{id} = +1V$) $V_{CC} = +15V$, $V_o = +2V$	20	40	70	mA
I_{sink}	Output Sink Current ($V_{id} = -1V$) $V_{CC} = +15V$, $V_o = +2V$ $V_{CC} = +15V$, $V_o = +0.2V$	10 12	20 50		mA μA

ELECTRICAL CHARACTERISTICS (continued)

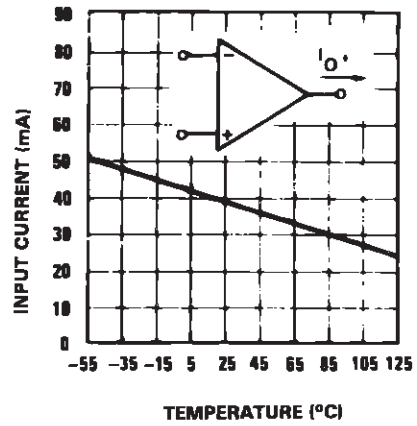
Symbol	Parameter	LM124 - LM224 - LM324			Unit
		Min.	Typ.	Max.	
V _{OH}	High Level Output Voltage (V _{CC} = +30V) T _{amb} = +25°C T _{min.} ≤ T _{amb} ≤ T _{max.} R _L = 2kΩ	26	27		V
		26			
	T _{amb} = +25°C T _{min.} ≤ T _{amb} ≤ T _{max.} (V _{CC} = +5V, R _L = 2kΩ) R _L = 10kΩ	27	28		
		27			
	T _{amb} = +25°C T _{min.} ≤ T _{amb} ≤ T _{max.}	3.5			
		3			
V _{OL}	Low Level Output Voltage (R _L = 10kΩ) T _{amb} = +25°C T _{min.} ≤ T _{amb} ≤ T _{max.}		5	20 20	mV
SR	Slew Rate V _{CC} = 15V, V _I = 0.5 to 3V, R _L = 2kΩ, C _L = 100pF, unity gain)		0.4		V/μs
GBP	Gain Bandwidth Product V _{CC} = 30V, f = 100kHz, V _{in} = 10mV R _L = 2kΩ, 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 = 1kHz, R _s = 100Ω, V _{CC} = 30V		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 (note 5) 1kHz ≤ f ≤ 20kHz		120		dB

- Notes :**
- Short-circuits from the output to V_{CC} can cause excessive heating if V_{CC} > 15V. The maximum output current is approximately 40mA independent of the magnitude of V_{CC}. Destructive dissipation can result from simultaneous short-circuit on all amplifiers.
 - The direction of the input current is out of the IC. This current is essentially constant, independent of the state of the output so no loading change exists on the input lines.
 - V_o = 1.4V, R_s = 0Ω, 5V < V_{CC} < 30V, 0 < V_{ic} < V_{CC} - 1.5V
 - The input common-mode voltage of 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_{CC} - 1.5V, but either or both inputs can go to +32V without damage.
 - Due to the 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 capacitance increases at higher frequencies.
 - 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 diodes 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 duration than an input is driven negative.
This is not destructive and normal output will set up again for input voltage higher than -0.3V.

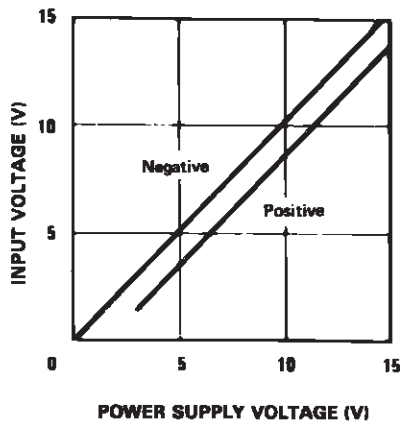
INPUT BIAS CURRENT
versus AMBIENT TEMPERATURE



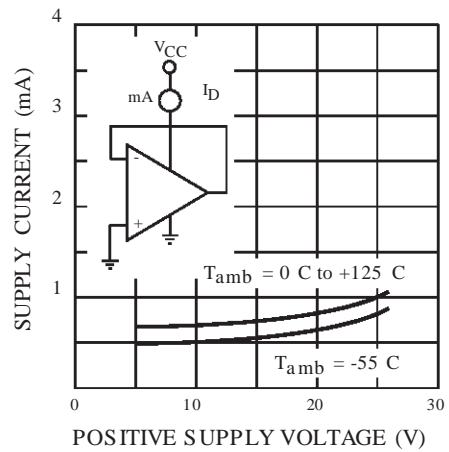
CURRENT LIMITING (Note 8)



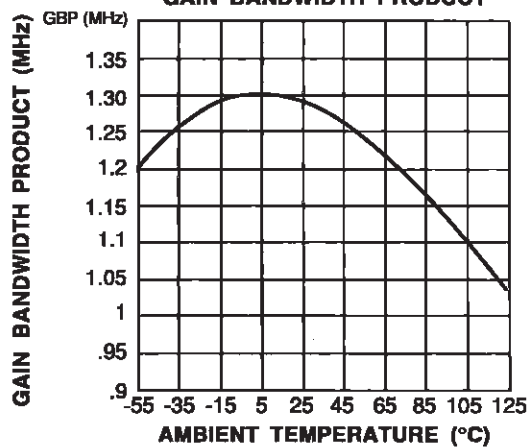
INPUT VOLTAGE RANGE



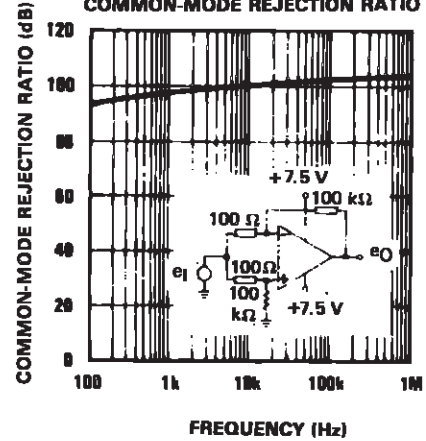
SUPPLY CURRENT



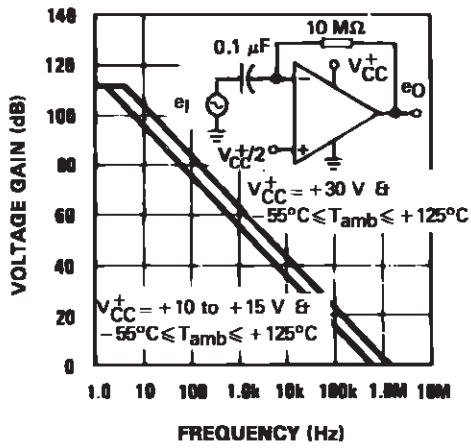
GAIN BANDWIDTH PRODUCT



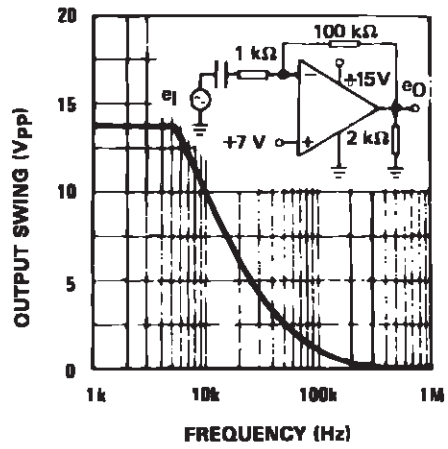
COMMON-MODE REJECTION RATIO



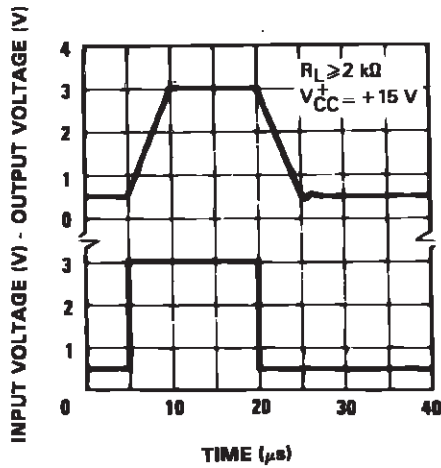
OPEN LOOP FREQUENCY RESPONSE



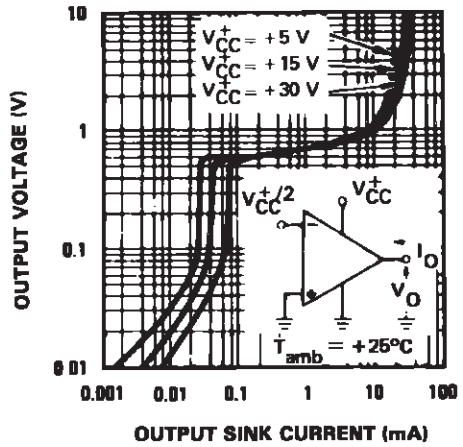
LARGE SIGNAL FREQUENCY RESPONSE



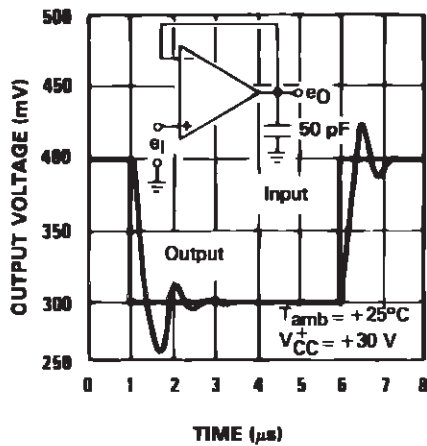
VOLTAGE FOLLOWER PULSE RESPONSE



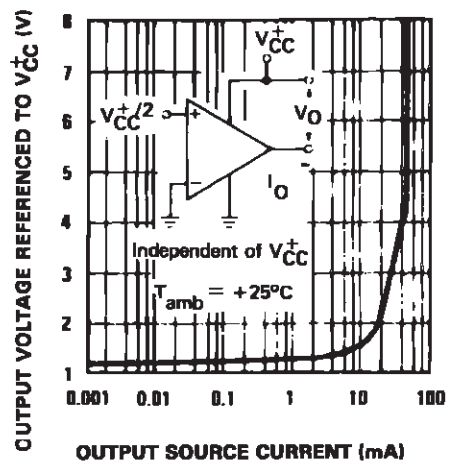
OUTPUT CHARACTERISTICS (CURRENT SINKING)

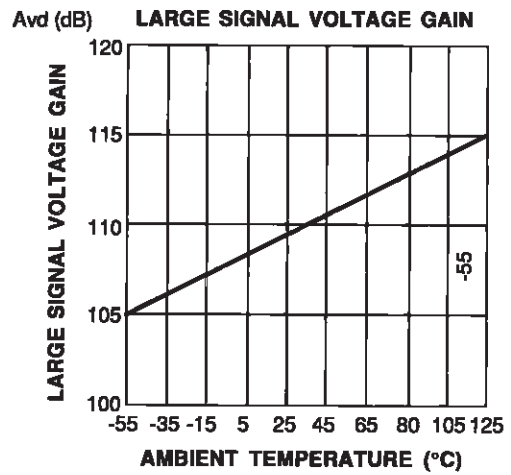
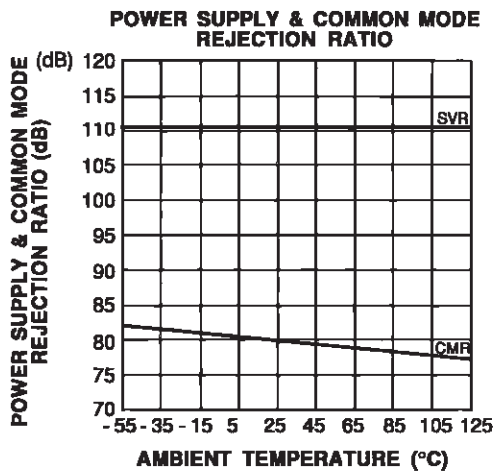
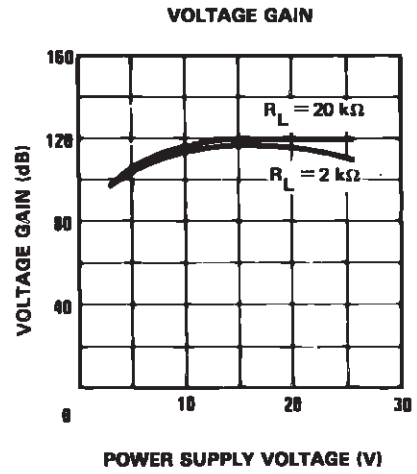
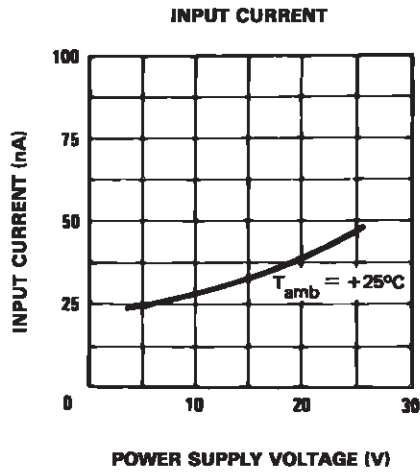


VOLTAGE FOLLOWER PULSE RESPONSE (SMALL SIGNAL)



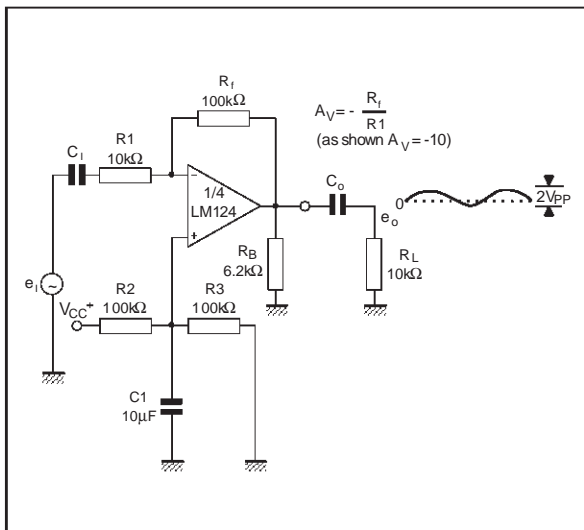
OUTPUT CHARACTERISTICS (CURRENT SOURCING)



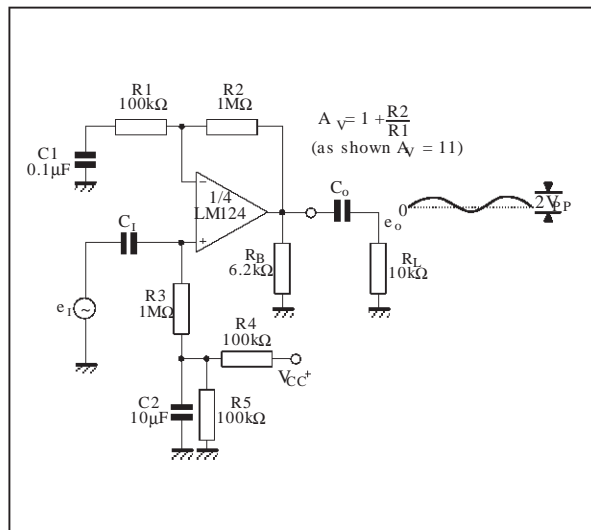


TYPICAL SINGLE - SUPPLY APPLICATIONS

AC COUPLED INVERTING AMPLIFIER

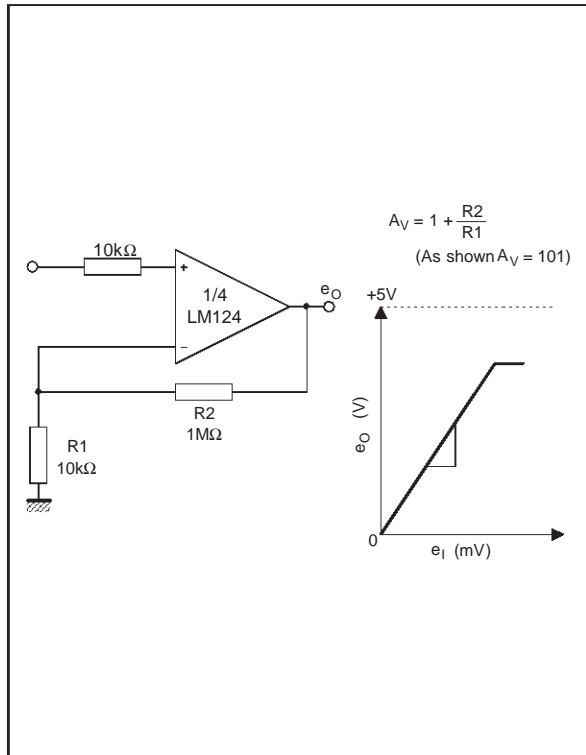


AC COUPLED NON-INVERTING AMPLIFIER

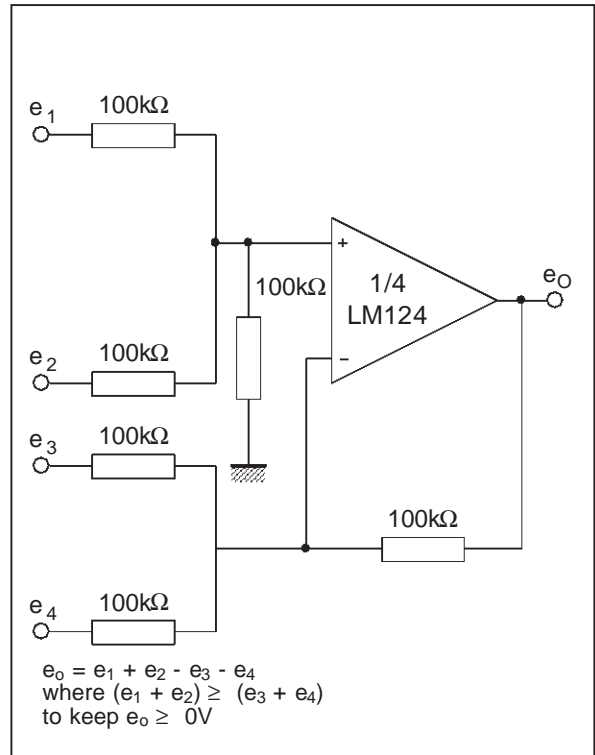


TYPICAL SINGLE - SUPPLY APPLICATIONS

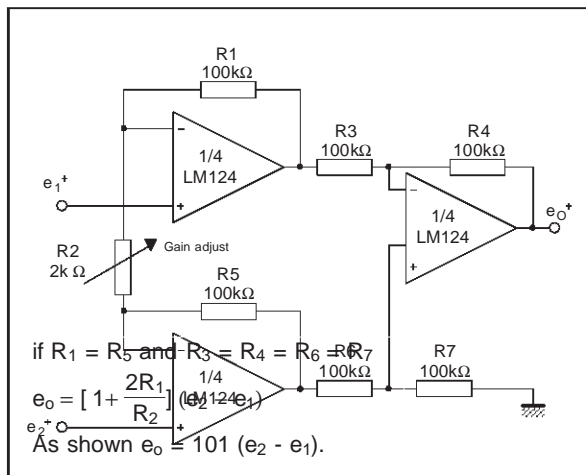
NON-INVERTING DC GAIN



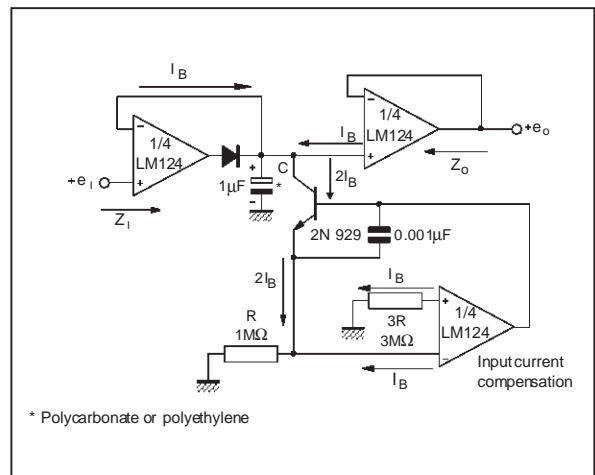
DC SUMMING AMPLIFIER



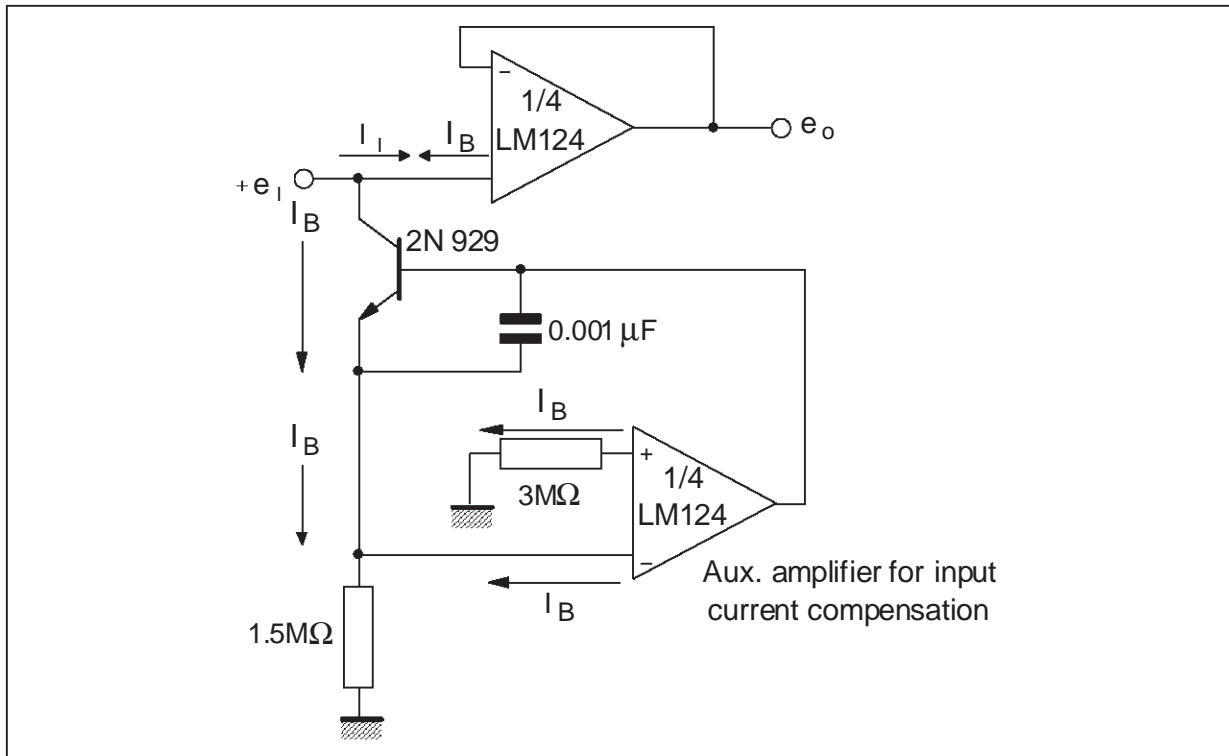
HIGH INPUT Z ADJUSTABLE GAIN DC INSTRUMENTATION AMPLIFIER



LOW DRIFT PEAK DETECTOR

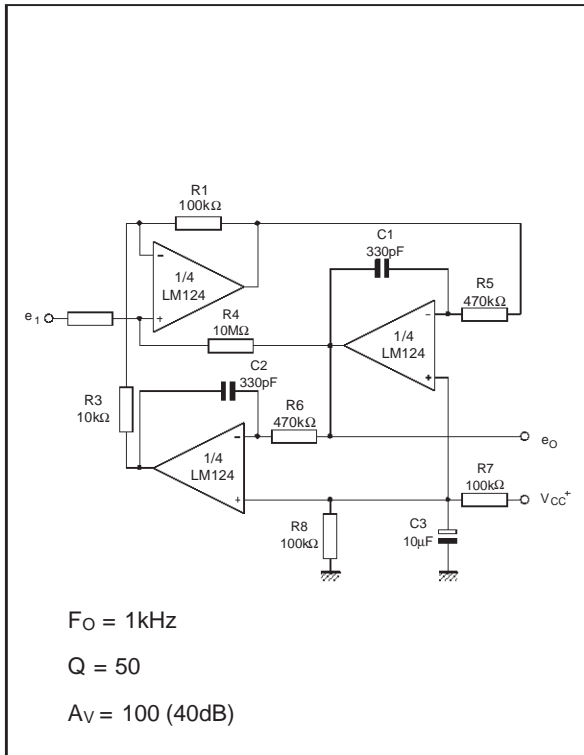


USING SYMMETRICAL AMPLIFIERS TO REDUCE INPUT CURRENT (GENERAL CONCEPT)

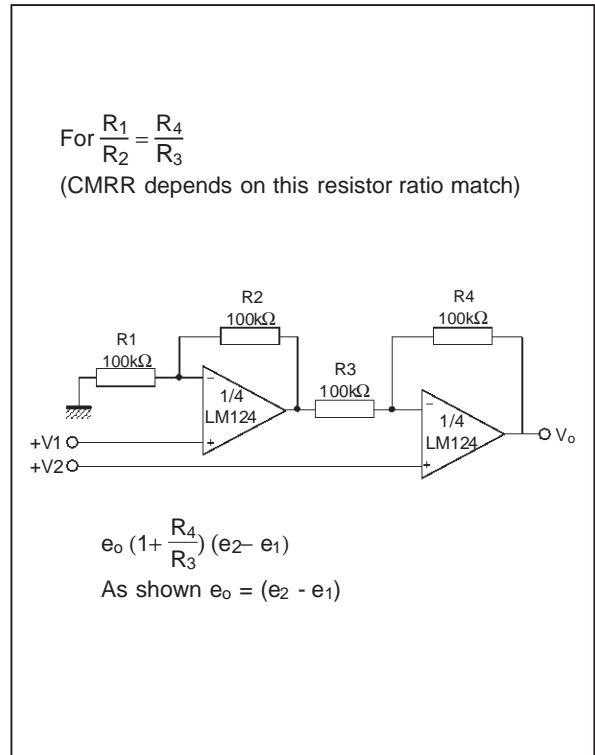


TYPICAL SINGLE - SUPPLY APPLICATIONS

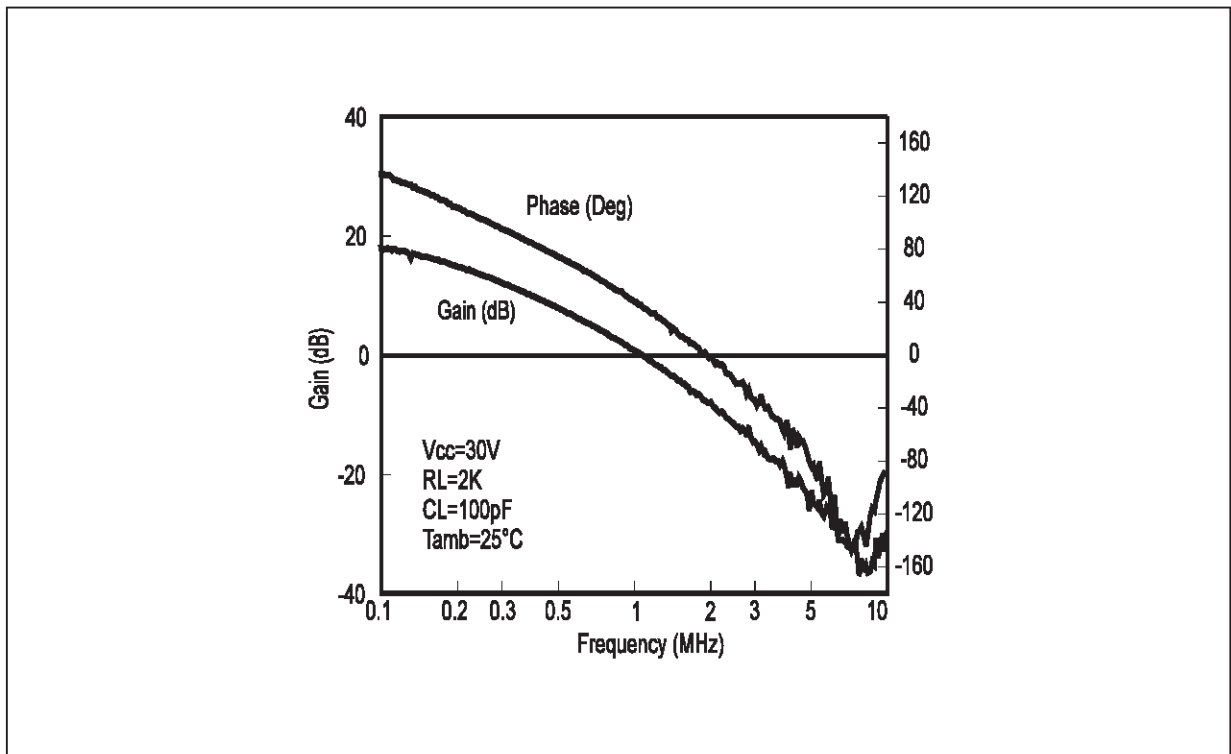
ACTIVER BANDPASS FILTER



HIGH INPUT Z, DC DIFFERENTIAL AMPLIFIER



VOLTAGE GAIN AND PHASE vs FREQUENCY



- LARGE VOLTAGE GAIN : 100dB
- VERY LOW SUPPLY CURRENT/AMPLI : 375µA
- LOW INPUT BIAS CURRENT : 20nA
- LOW INPUT OFFSET VOLTAGE : 2mV
- LOW INPUT OFFSET CURRENT : 2nA
- WIDE POWER SUPPLY RANGE :
SINGLE SUPPLY : +3V to +30V
DUAL SUPPLIES : ±1.5V to ±15V

Applies to : LM124-LM224-LM324

** Standard Linear Ics Macromodels, 1993.

** CONNECTIONS :

- * 1 INVERTING INPUT
- * 2 NON-INVERTING INPUT
- * 3 OUTPUT
- * 4 POSITIVE POWER SUPPLY
- * 5 NEGATIVE POWER SUPPLY

.SUBCKT LM124 1 3 2 4 5 (analog)

.MODEL MDTH D IS=1E-8 KF=3.104131E-15
CJO=10F

* INPUT STAGE

CIP 2 5 1.000000E-12
CIN 1 5 1.000000E-12
EIP 10 5 2 5 1
EIN 16 5 1 5 1
RIP 10 11 2.600000E+01
RIN 15 16 2.600000E+01
RIS 11 15 2.003862E+02
DIP 11 12 MDTH 400E-12
DIN 15 14 MDTH 400E-12
VOFP 12 13 DC 0
VOFN 13 14 DC 0
IPOL 13 5 1.000000E-05
CPS 11 15 3.783376E-09
DINN 17 13 MDTH 400E-12
VIN 17 5 0.000000E+00

DINR 15 18 MDTH 400E-12
VIP 4 18 2.000000E+00
FCP 4 5 VOFP 3.400000E+01
FCN 5 4 VOFN 3.400000E+01
FIBP 2 5 VOFN 2.000000E-03
FIBN 5 1 VOFP 2.000000E-03
* AMPLIFYING STAGE
FIP 5 19 VOFP 3.600000E+02
FIN 5 19 VOFN 3.600000E+02
RG1 19 5 3.652997E+06
RG2 19 4 3.652997E+06
CC 19 5 6.000000E-09
DOPM 19 22 MDTH 400E-12
DONM 21 19 MDTH 400E-12
HOPM 22 28 VOUT 7.500000E+03
VIPM 28 4 1.500000E+02
HONM 21 27 VOUT 7.500000E+03
VINM 5 27 1.500000E+02
EOUT 26 23 19 5 1
VOUT 23 5 0
ROUT 26 3 20
COUT 3 5 1.000000E-12
DOP 19 25 MDTH 400E-12
VOP 4 25 2.242230E+00
DON 24 19 MDTH 400E-12
VON 24 5 7.922301E-01
.ENDS

ELECTRICAL CHARACTERISTICS

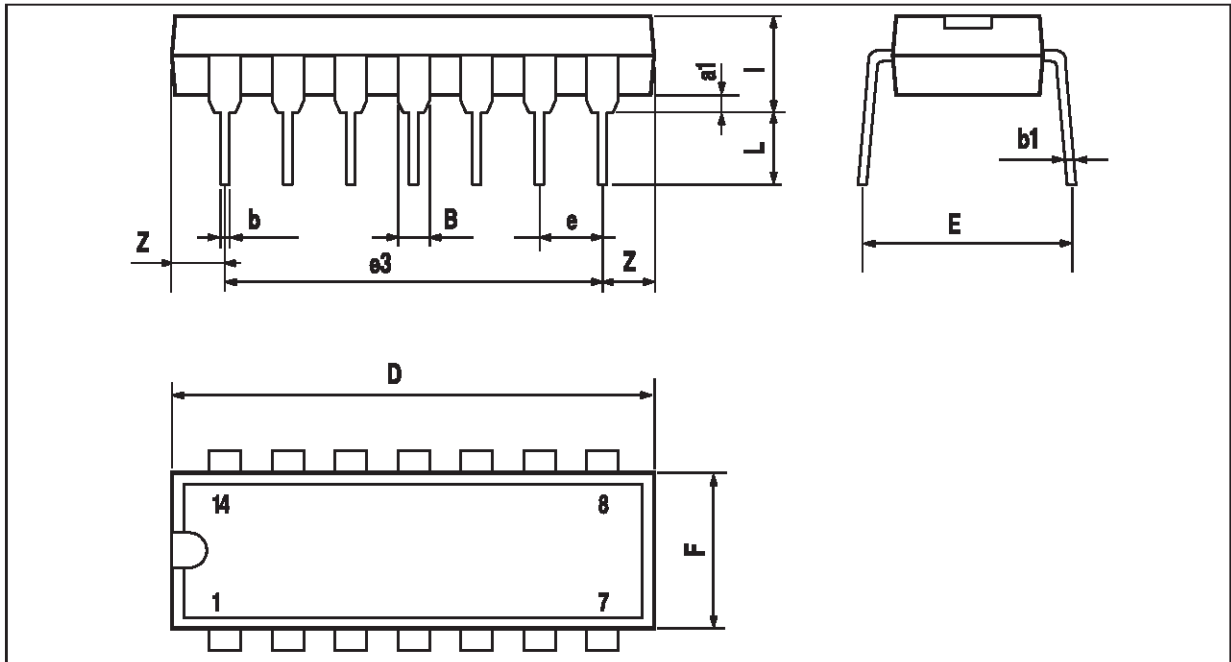
V_{CC}⁺ = +5V, V_{CC}⁻ = 0V, T_{amb} = 25°C (unless otherwise specified)

Symbol	Conditions	Value	Unit
V _{io}		0	mV
A _{vd}	R _L = 2kΩ	100	V/mV
I _{CC}	No load, per operator	350	µA
V _{icm}		-15 to +13.5	V
V _{OH}	R _L = 2kΩ (V _{CC} ⁺ = 15V)	+13.5	V
V _{OL}	R _L = 10kΩ	5	mV
I _{OS}	V _O = +2V, V _{CC} = +15V	+40	mA
GBP	R _L = 2kΩ, C _L = 100pF	1.3	MHz
SR	R _L = 2kΩ, C _L = 100pF	0.4	V/µs



LM124 - LM224 - LM324

PACKAGE MECHANICAL DATA
14 PINS - PLASTIC DIP



Dimensions	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
a1	0.51			0.020		
B	1.39		1.65	0.055		0.065
b		0.5			0.020	
b1		0.25			0.010	
D			20			0.787
E		8.5			0.335	
e		2.54			0.100	
e3		15.24			0.600	
F			7.1			0.280
i			5.1			0.201
L		3.3			0.130	
Z	1.27		2.54	0.050		0.100

Mechanical Dimensions (Continued)

Package

Dimensions in millimeters

14-SOP

