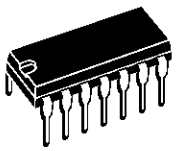
SGS-THOMSON MICROELECTRONICS

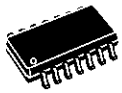
LM124
LM224 - LM324

LOW POWER QUAD OPERATIONAL AMPLIFIERS

- LARGE VOLTAGE GAIN : 100dB
- VERY LOW SUPPLY CURRENT/AMPLI : 375µA
- 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 : ±1.5V TO ±15V



N
DIP14
(Plastic Package)



D
SO14
(Plastic Micropackage)

DESCRIPTION

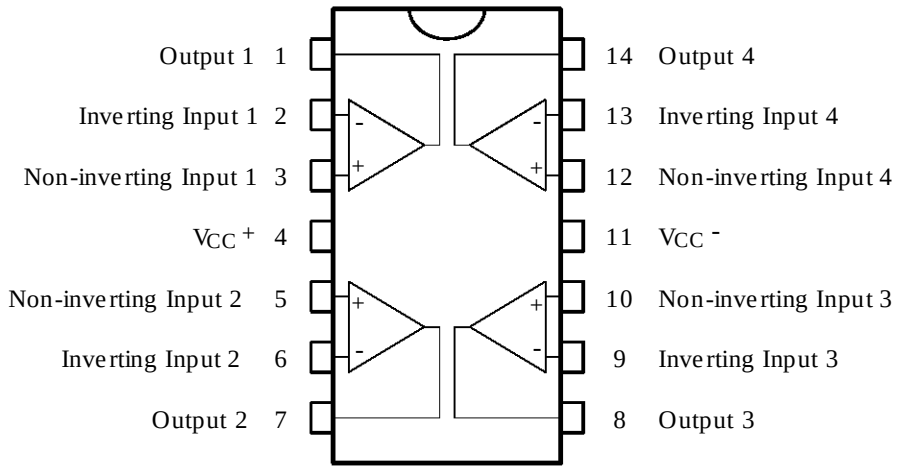
These circuits consist of four independent, high gain, internally frequency compensated operational amplifiers which were designed specifically for automotive and industrial control systems. They operate from a single power supply over a wide range of voltages. Operation from split power supplies is 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
LM124	-55°C, +125°C	•	•
LM224	-40°C, +105°C	•	•
LM324	0°C, +70°C	•	•
Example : LM224N			

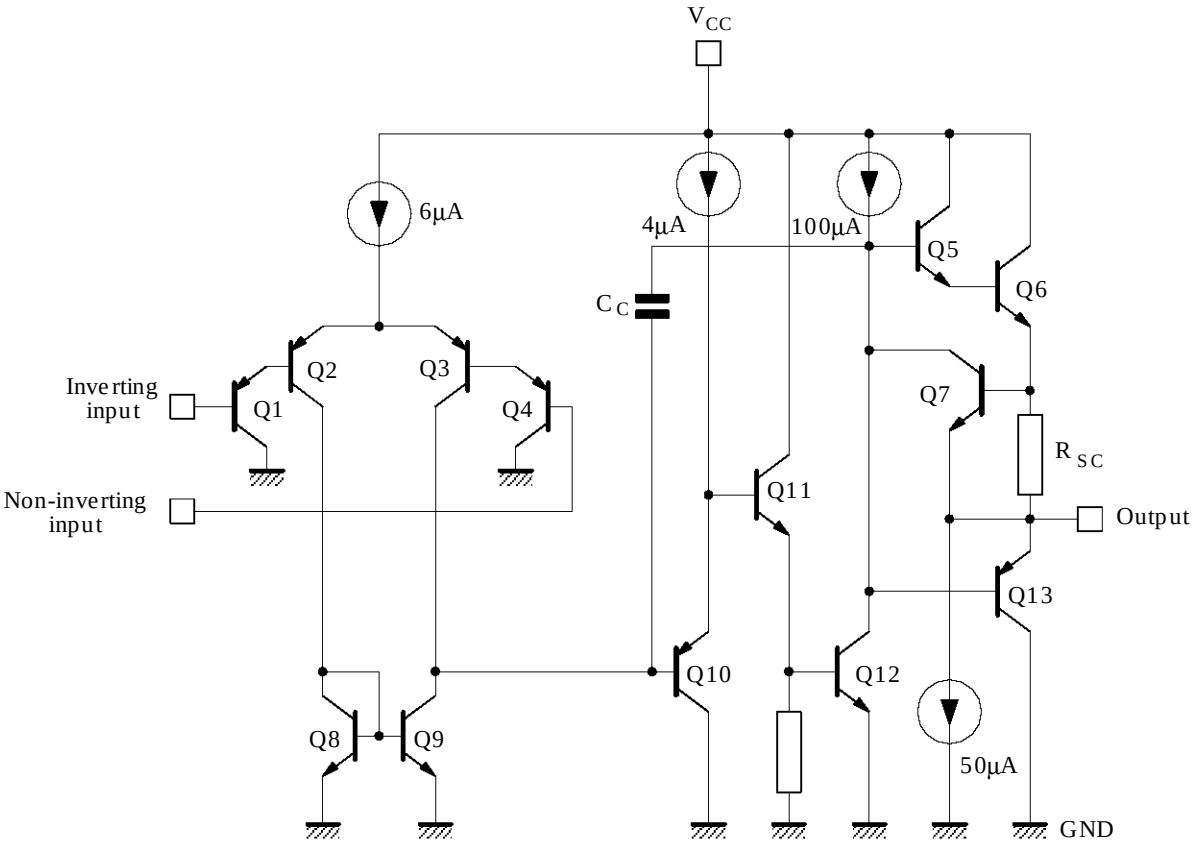
124-01.TBL

PIN CONNECTIONS (top view)



124-01.EPS

SCHEMATIC DIAGRAM (1/4 LM124)



124-02.EPS

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 N Suffix D Suffix	500 -	500 400	500 400	mW 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

124-02.TBL

ELECTRICAL CHARACTERISTICS

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

Symbol	Parameter	LM124 - LM224 - LM324			Unit
		Min.	Typ.	Max.	
V_{io}	Input Offset Voltage (note 3) T_{amb} = +25°C LM324 $T_{min.} \le T_{amb} \le T_{max}$. LM324		2	5 7 7 9	mV
I_{io}	Input Offset Current T_{amb} = +25°C $T_{min.} \le T_{amb} \le T_{max}$.		2	30 100	nA
I_{ib}	Input Bias Current (note 2) T_{amb} = +25°C $T_{min.} \le T_{amb} \le T_{max}$.		20	150 300	nA
A_{vd}	Large Signal Voltage Gain (V_{CC}^+ = +15V, R_L = 2kΩ, V_O = 1.4V to 11.4V) T_{amb} = +25°C $T_{min.} \le T_{amb} \le T_{max}$.	 50 25	 100		V/mV
SVR	Supply Voltage Rejection Ratio ($R_S \le 10k\Omega$) (V_{CC}^+ = 5V to 30V) 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} = +30V $T_{min.} \le T_{amb} \le T_{max}$. 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°C $T_{min.} \le T_{amb} \le T_{max}$.	 0 0		 V_{CC} -1.5 V_{CC} -2	V
CMR	Common-mode Rejection Ratio ($R_S \le 10k\Omega$) T_{amb} = +25°C $T_{min.} \le T_{amb} \le T_{max}$	 70 60	 80		dB
I_{source}	Output Current Source (V_{id} = +1V) V_{CC} = +15V, V_o = +2V	 20	 40		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
I_o	Short Circuit to Ground V_{CC} = +15V		 40	 60	mA

124-03.TBL

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 R_L = 2kΩ $T_{min.} \le T_{amb} \le T_{max.}$ T_{amb} = +25°C R_L = 10kΩ $T_{min.} \le T_{amb} \le T_{max.}$ (V_{CC} = +5V, R_L = 2kΩ) T_{amb} = +25°C $T_{min.} \le T_{amb} \le T_{max.}$	 26 26 27 27 3.5 3	 27 28 	 	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} = 15V, V_I = 0.5 to 3V, R_L = 2kΩ, C_L = 100pF, T_{amb} = +25°C, unity gain)		 0.4		V/µs
GBP	Gain Bandwidth Product V_{CC} = 30V, f = 100kHz, T_{amb} = +25°C, 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, T_{amb} = +25°C, 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

124-04.TBL

Notes : 1. 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.

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 no loading change exists on the input lines.

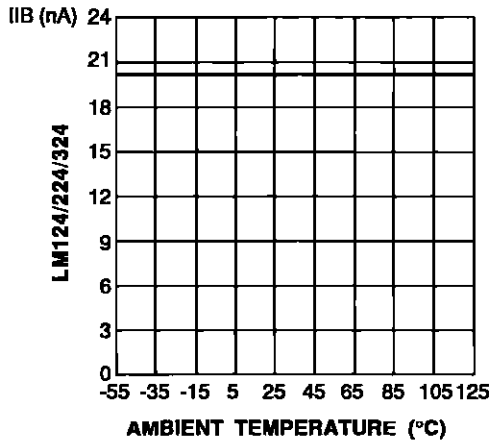
3. V_o = 1.4V, R_s = 0Ω, 5V < V_{CC}^+ < 30V, 0 < V_{ic} < V_{CC}^+ - 1.5V

4. 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.

5. 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 frequences.

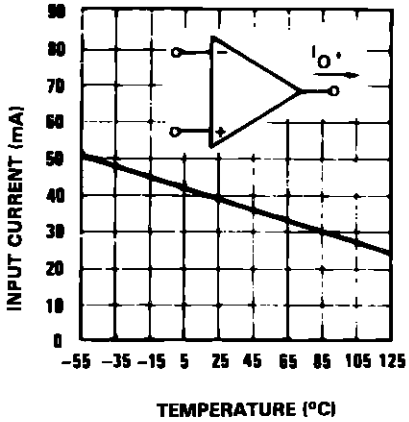
6. This input current only exists when the voltage at any of the input leads is driven negative. It is due to the collector-base junction of the input PNP transistor becoming forward biased and thereby acting as input diodes clamps. In addition to this diode action, there is also NPN parasitic action 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 vs AMBIENT TEMPERATURE



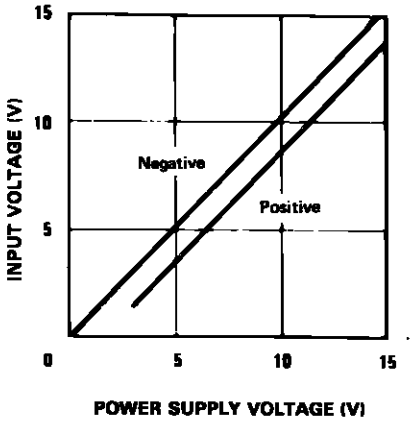
124-03.EPS

CURRENT LIMITING (Note 8)



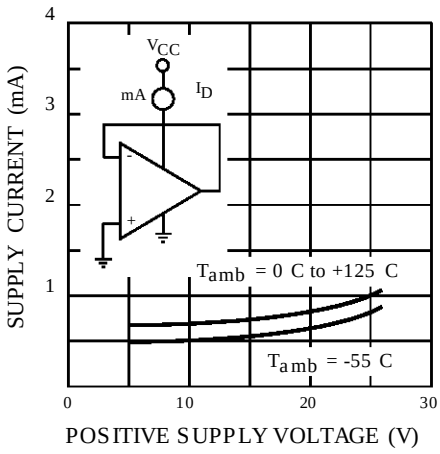
124-04.EPS

INPUT VOLTAGE RANGE



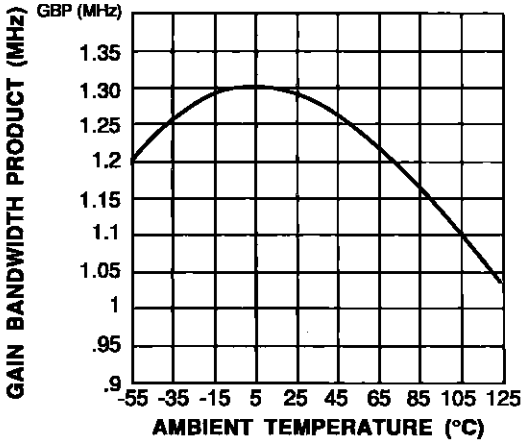
124-05.EPS

SUPPLY CURRENT



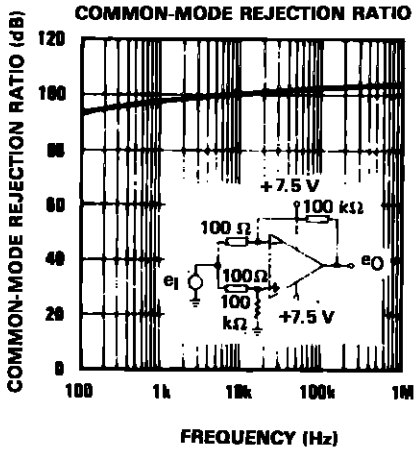
124-06.EPS

GAIN BANDWIDTH PRODUCT



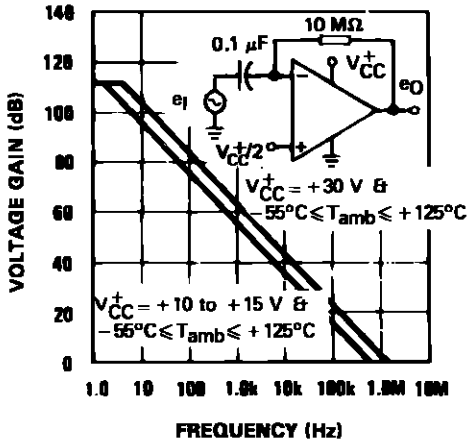
124-07.EPS

COMMON-MODE REJECTION RATIO

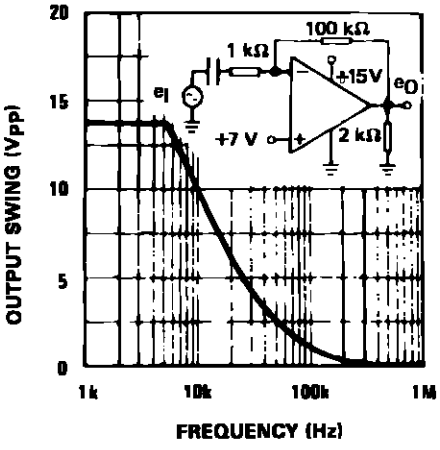


124-08.EPS

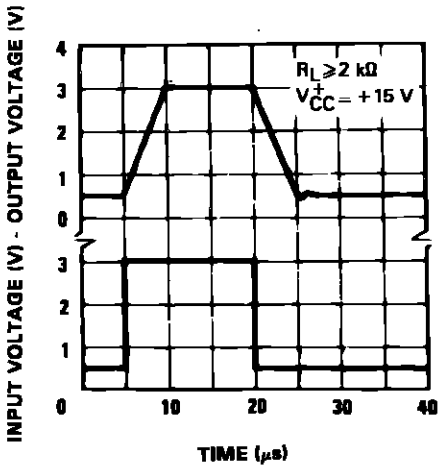
OPEN LOOP FREQUENCY RESPONSE



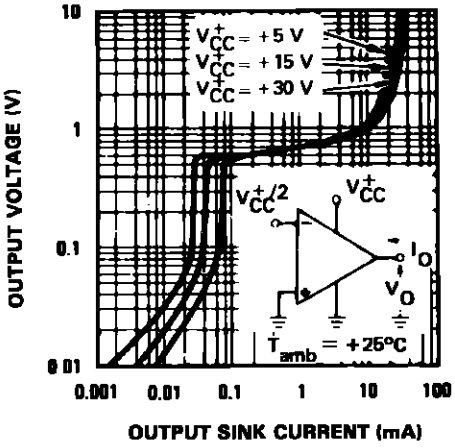
LARGE SIGNAL FREQUENCY RESPONSE



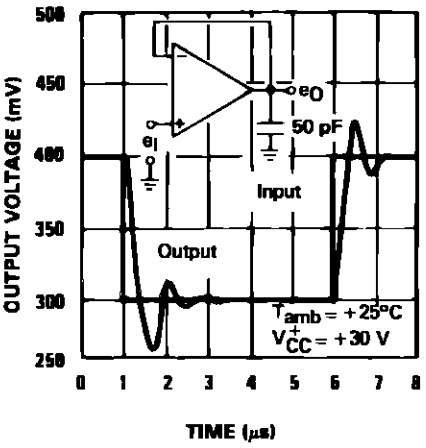
VOLTAGE FOLLOWER PULSE RESPONSE



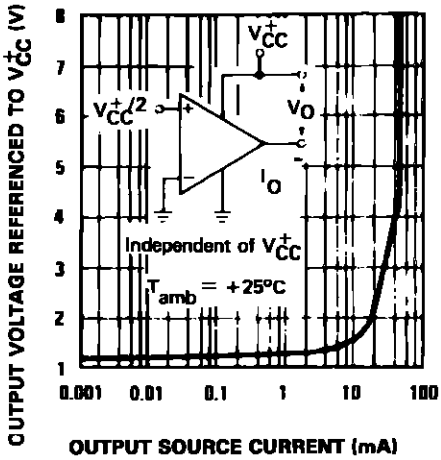
OUTPUT CHARACTERISTICS (CURRENT SINKING)



VOLTAGE FOLLOWER PULSE RESPONSE (SMALL SIGNAL)

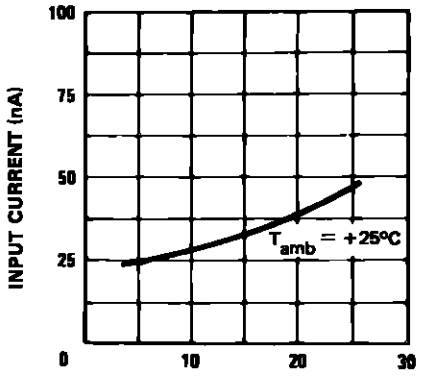


OUTPUT CHARACTERISTICS (CURRENT SOURCING)



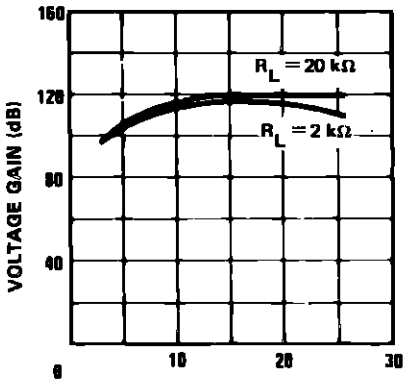
124-09.EPS

INPUT CURRENT



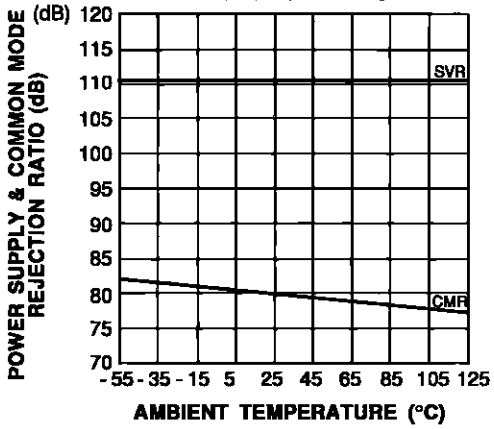
124-10.EPS

VOLTAGE GAIN



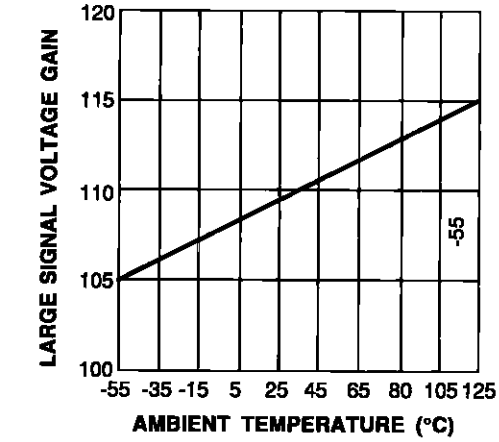
124-11.EPS

POWER SUPPLY & COMMON MODE REJECTION RATIO



124-12.EPS

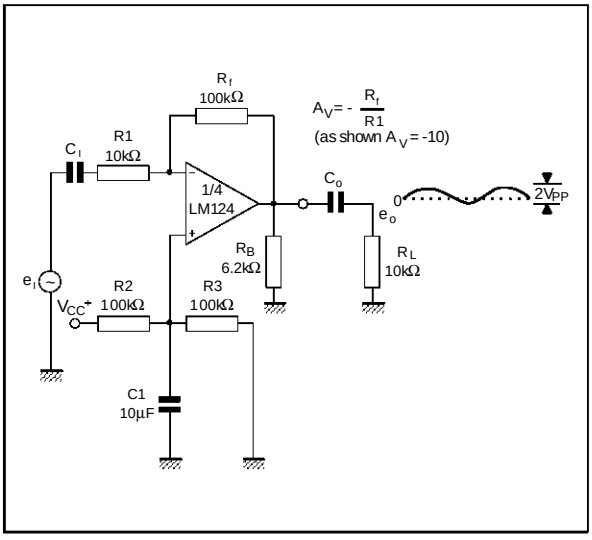
LARGE SIGNAL VOLTAGE GAIN



124-13.EPS

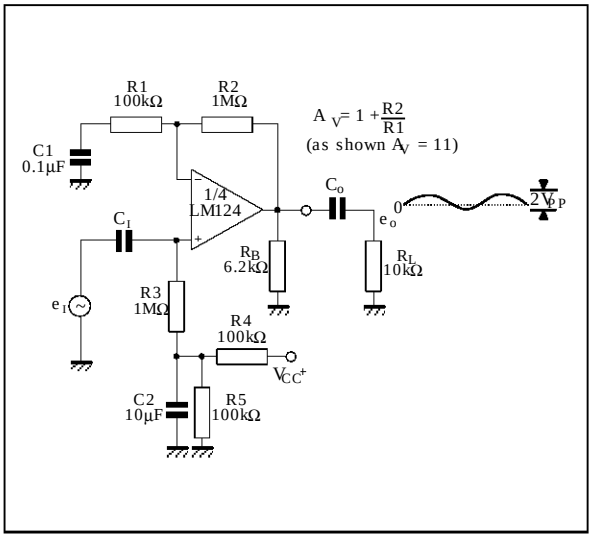
TYPICAL SINGLE - SUPPLY APPLICATIONS

AC COUPLED INVERTING AMPLIFIER



124-14.EPS

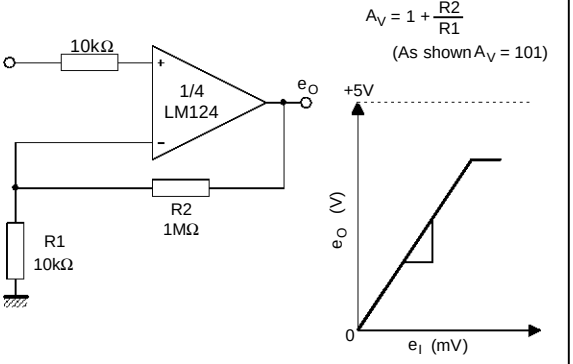
AC COUPLED NON-INVERTING AMPLIFIER



124-15.EPS

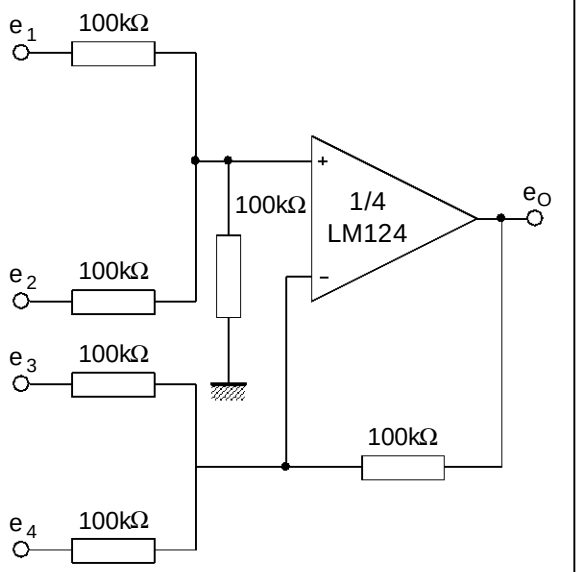
TYPICAL SINGLE - SUPPLY APPLICATIONS

NON-INVERTING DC GAIN



124-16.EPS

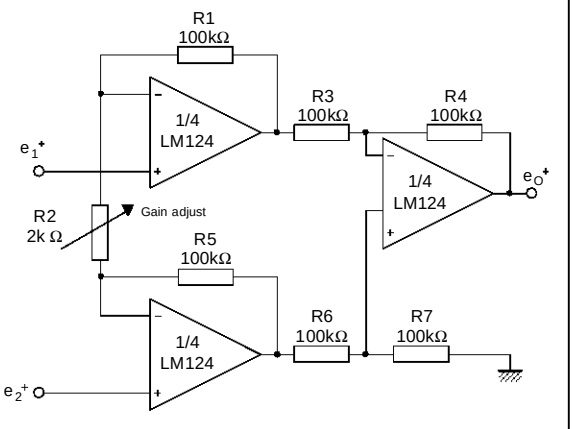
DC SUMMING AMPLIFIER



$e_o = e_1 + e_2 - e_3 - e_4$
where $(e_1 + e_2) \geq (e_3 + e_4)$
to keep $e_o \geq$ 0V

124-17.EPS

HIGH INPUT Z ADJUSTABLE GAIN DC INSTRUMENTATION AMPLIFIER



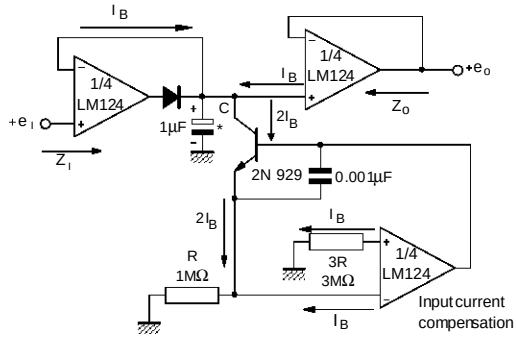
if $R_1 = R_5$ and $R_3 = R_4 = R_6 = R_7$

$e_o = [1 + \frac{2R_1}{R_2}] (e_2 - e_1)$

As shown $e_o = 101 (e_2 - e_1)$.

124-18.EPS

LOW DRIFT PEAK DETECTOR

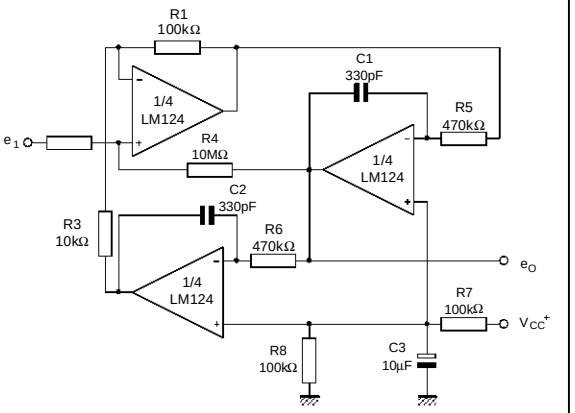


* Polycarbonate or polyethylene

124-19.EPS

TYPICAL SINGLE - SUPPLY APPLICATIONS

ACTIVER BANDPASS FILTER



F_O = 1kHz

Q = 50

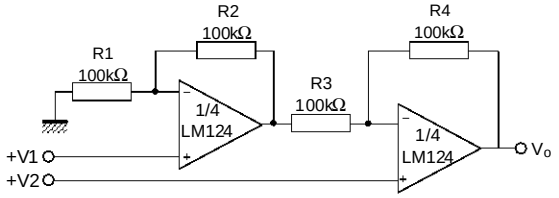
A_V = 100 (40dB)

124-20.EPS

HIGH INPUT Z, DC DIFFERENTIAL AMPLIFIER

For $\frac{R_1}{R_2} = \frac{R_4}{R_3}$

(CMRR depends on this resistor ratio match)

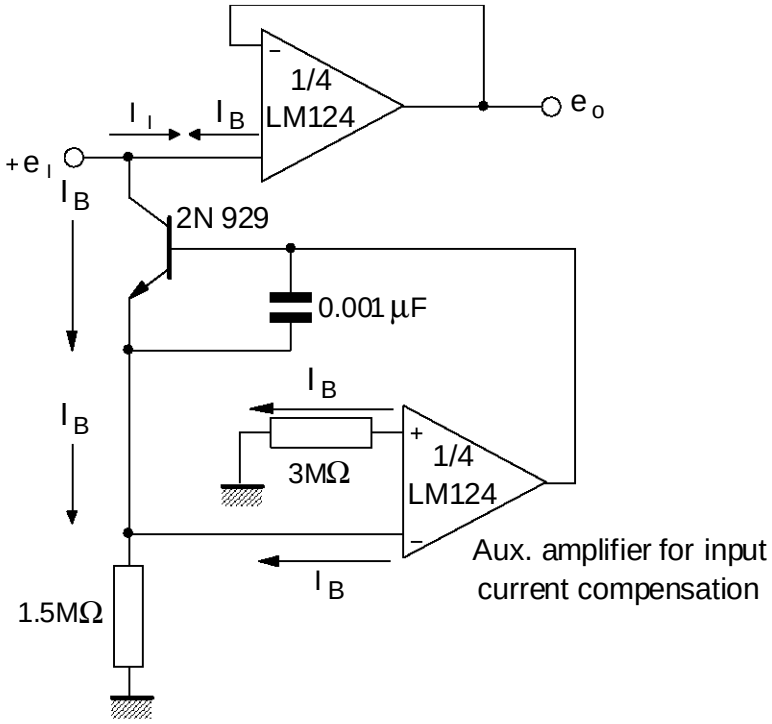


$e_o (1+\frac{R_4}{R_3}) (e_2 - e_1)$

As shown $e_o = (e_2 - e_1)$

124-21.EPS

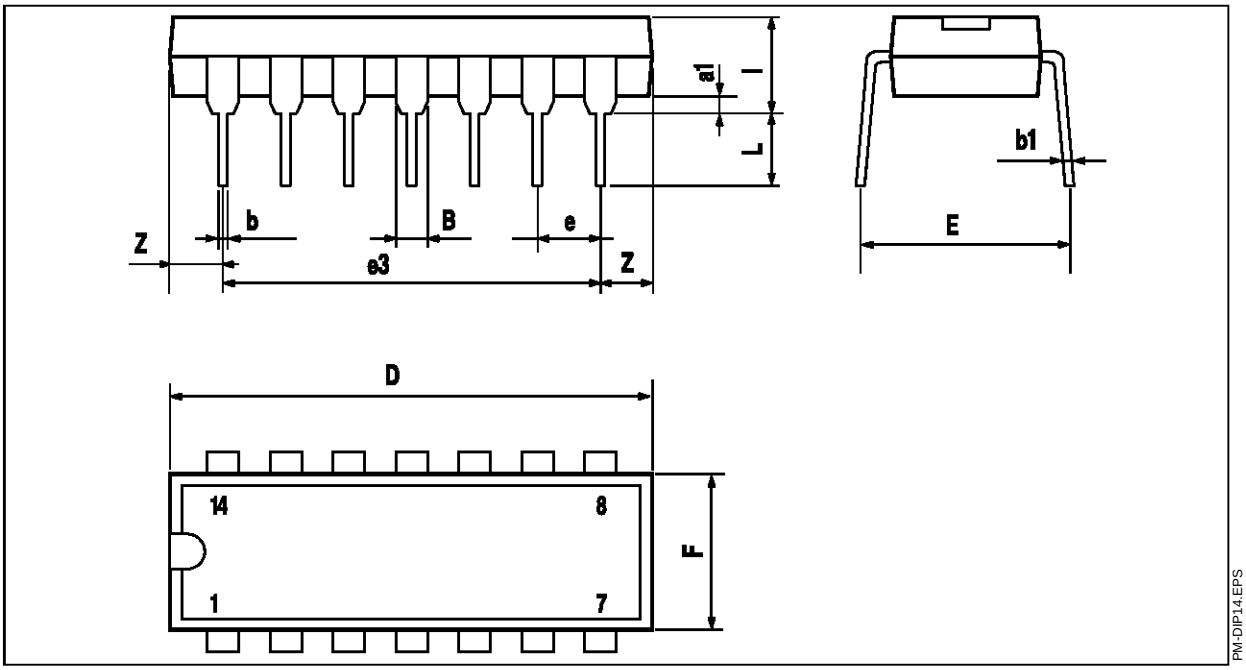
USING SYMMETRICAL AMPLIFIERS TO REDUCE INPUT CURRENT (GENERAL CONCEPT)



124-22.EPS

PACKAGE MECHANICAL DATA

14 PINS - PLASTIC DIP

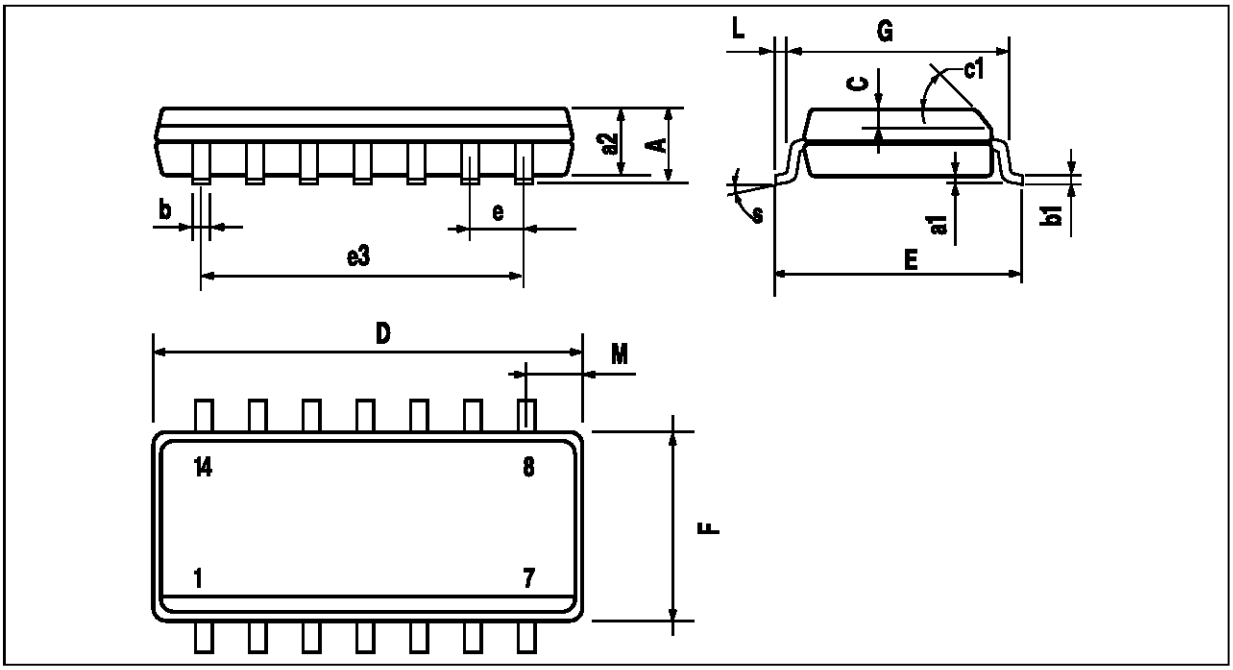


Dimensions	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
a1	0.51			0.020		
B	1.39		1.65	0.055		0.065
b		0.5			0.020	
b1		0.25			0.010	
D			20			0.787
E		8.5			0.335	
e		2.54			0.100	
e3		15.24			0.600	
F			7.1			0.280
i			5.1			0.201
L		3.3			0.130	
Z	1.27		2.54	0.050		0.100

DIP14.TBL

PACKAGE MECHANICAL DATA

14 PINS - PLASTIC MICROPACKAGE (SO)



PM-SO14.EPS

Dimensions	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.75			0.069
a1	0.1		0.2	0.004		0.008
a2			1.6			0.063
b	0.35		0.46	0.014		0.018
b1	0.19		0.25	0.007		0.010
C		0.5			0.020	
c1	45° (typ.)					
D	8.55		8.75	0.336		0.334
E	5.8		6.2	0.228		0.244
e		1.27			0.050	
e3		7.62			0.300	
F	3.8		4.0	0.150		0.157
G	4.6		5.3	0.181		0.208
L	0.5		1.27	0.020		0.050
M			0.68			0.027
S	8° (max.)					

SO14.TBL

ORDER CODE :