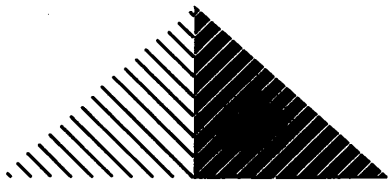


Aspect Development, Inc.

During QA it was found that pages within this section are missing from the original source document. These pages are not available from the manufacturer at this time. Aspect Development, Inc. apologizes for any inconvenience.

Please contact VIP Customer Support at (603) 880-3764x25 or the manufacturer if you have any questions.

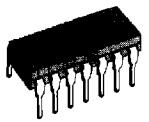
Thank You

SGS-THOMSON MICROELECTRONICS

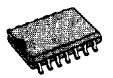
LM124/A - LM224/A LM324/A - LM2902

LOW POWER QUAD OPERATIONAL AMPLIFIERS

- 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



N
DIP14
(Plastic Package)



D
SO14
(Plastic Micropackage)

J
CERDIP14
(Cerdip Package)

DESCRIPTION

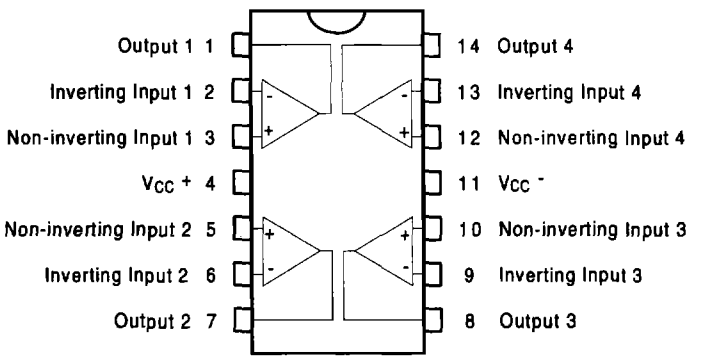
These circuits consist of four independent, high gain, internally frequency compensated operational amplifiers which were designed specifically for automotive and industrial control systems. They operate from a single power supply over a wide range of voltages. Operation from split power supplies is 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	J	D
LM124/A	– 55°C, +125°C	•	•	•
LM224/A	–40°C, +105°C	•	•	•
LM324/A	0°C, +70°C	•	•	•
LM2902	–40°C, +105°C	•	•	•
Examples : LM124J, LM224N				

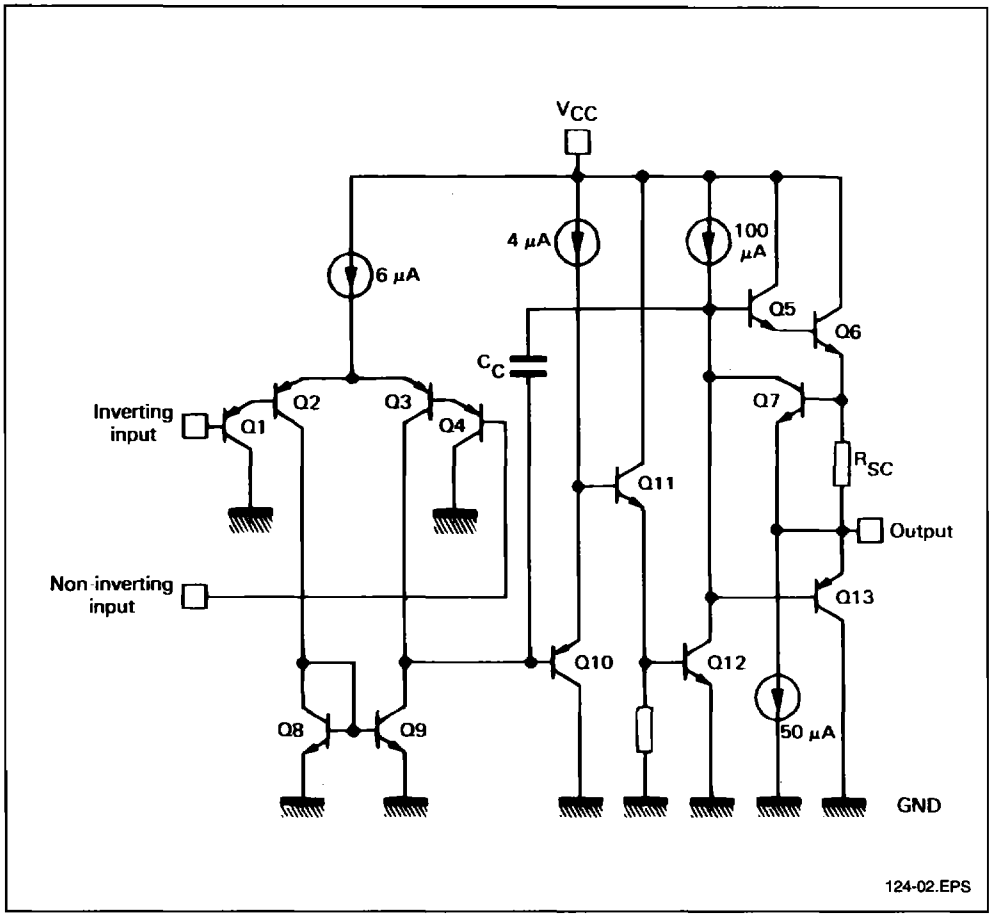
124-01.TBL

PIN CONNECTIONS (top view)



124-01.EPS

SCHEMATIC DIAGRAM (1/4 LM124)



ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	LM124,A	LM224,A 2902	LM324,A	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, J Suffix D Suffix	500 -	500 400	500 400	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}^- = Ground, V_O = 1.4V, T_{amb} = +25°C
(unless otherwise specified)

Symbol	Parameter	LM124A - LM224A LM324A			LM124 - LM224 LM324 - LM2902			Unit
		Min.	Typ.	Max.	Min.	Typ.	Max.	
V_{io}	Input Offset Voltage (note 3) T_{amb} = +25°C LM324, LM2902 $T_{min.} \le T_{amb} \le T_{max.}$ LM324, LM2902		2	3 5		2	5 7 7 9	mV
I_{io}	Input Offset Current T_{amb} = +25°C $T_{min.} \le T_{amb} \le T_{max.}$		2	20 40		2	30 40	nA
I_{ib}	Input Bias Current (note 2) T_{amb} = +25°C $T_{min.} \le T_{amb} \le T_{max.}$		20	100 200		20	150 200	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		 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		 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		 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	 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		 70 60	80		dB
I_o	Output Short-circuit Current (V_{id} = +1V) V_{CC} = +15V, V_o = +2V	20	40	60	20	40	60	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		10 12	20 50		mA µA

124-03.TBL

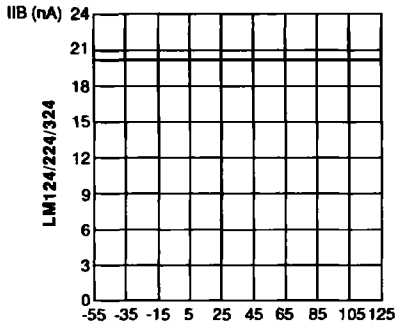
ELECTRICAL CHARACTERISTICS (continued)

Symbol	Parameter	LM124A - LM224A LM324A			LM124 - LM224 LM324 - LM 2902			Unit
		Min.	Typ.	Max.	Min.	Typ.	Max.	
V_{OH}	High Level Output Voltage (V_{CC} = +30V)							V
	T_{amb} = +25°C R_L = 2kΩ	26	27		26	27		
	$T_{min.} \le T_{amb} \le T_{max.}$	26			26			
	T_{amb} = +25°C R_L = 10kΩ	27	28		27	28		
	$T_{min.} \le T_{amb} \le T_{max.}$	27			27			
	(V_{CC} = +5V, R_L = 2kΩ)							
	T_{amb} = +25°C	3.5			3.5			
	$T_{min.} \le T_{amb} \le T_{max.}$	3			3			
V_{OL}	Low Level Output Voltage (R_L = 10kΩ)							mV
	T_{amb} = +25°C		5	20		5	20	
	$T_{min.} \le T_{amb} \le T_{max.}$			20			20	
SR	Slew Rate (V_{CC} = 15V, V_i = 0.5 to 3V, R_L = 2kΩ, C_L = 100pF, T_{amb} = +25°C, unity gain)	0.2	0.4		0.2	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)	0.7	1.3		0.7	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			0.015		%
e_n	Equivalent Input Noise Voltage (f = 1kHz, R_s = 100Ω, V_{CC} = 30V)		40			40		$\frac{nV}{\sqrt{Hz}}$
DV_{io}	Input Offset Voltage Drift		7	30		7	30	µV/°C
DI_{IO}	Input Offset Current Drift		10	200		10	200	pA/°C
V_{O1}/V_{O2}	Channel Separation (note 5) 1kHz ≤ f ≤ 20kHz		120			120		dB

Notes : 1. Short-circuits from the output to V_{CC} can cause excessive heating if V_{CC} > 15V. The maximum output curren is approximately 40mA independent of the magnitude of V_{CC}. Destructive dissipation can result from simulta neous short-circuit on all amplifiers.

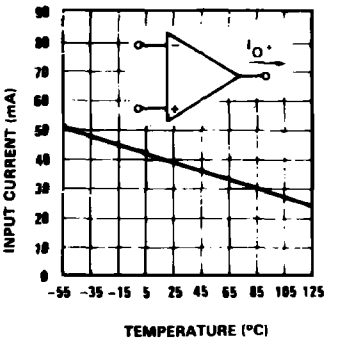
2. The direction of the input current is out of the IC. This current is essentially constant, independent of the state of the output so no loading change exists on the input lines.
3. V_o = 1.4V, R_s = 0Ω, 5V < V_{CC}^+ < 30V, 0 < V_{ic} < V_{CC}^+ - 1.5V
4. The input common-mode voltage of either input 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 be tween these external parts. This typically can be detected as this type of capacitance increases at higher fre quences.
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 inpu diodes clamps. In addition to this diode action, there is also NPN parasitic action on the IC chip. this transisto 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



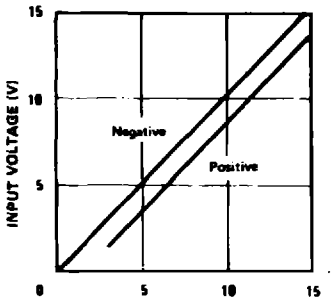
124-03.EPS

CURRENT LIMITING (Note 8)



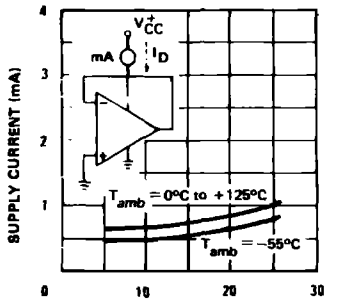
124-04.EPS

INPUT VOLTAGE RANGE



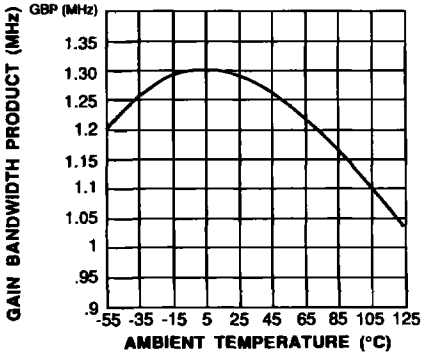
124-05.EPS

SUPPLY CURRENT



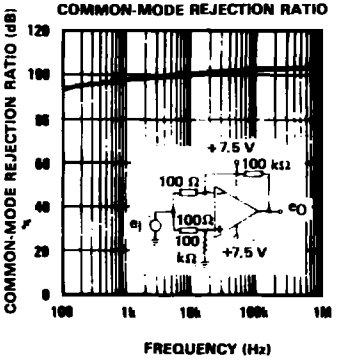
124-06.EPS

GAIN BANDWIDTH PRODUCT



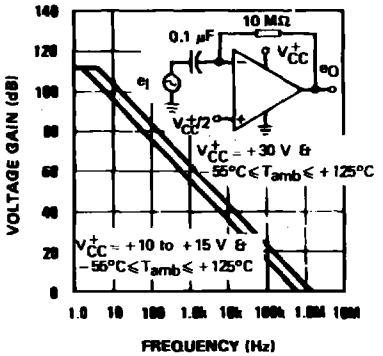
124-07.EPS

COMMON-MODE REJECTION RATIO

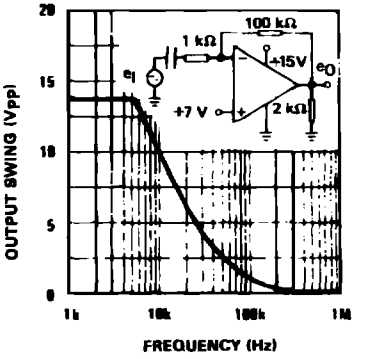


124-08.EPS

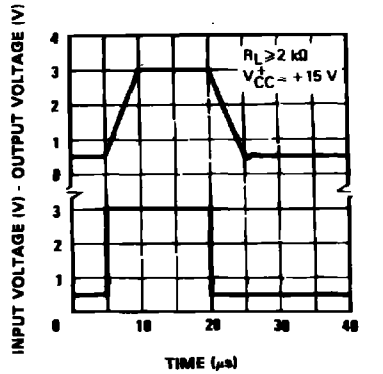
OPEN LOOP FREQUENCY RESPONSE



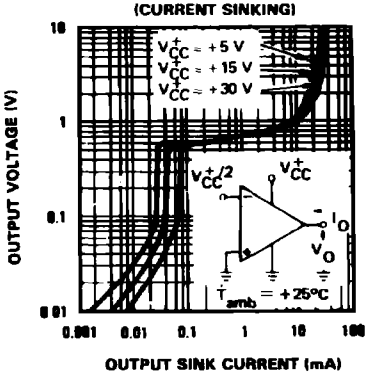
LARGE SIGNAL FREQUENCY RESPONSE



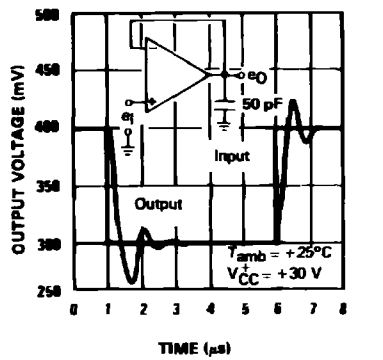
VOLTAGE FOLLOWER PULSE RESPONSE



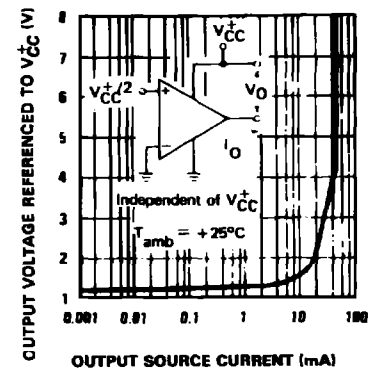
OUTPUT CHARACTERISTICS (CURRENT SINKING)



VOLTAGE FOLLOWER PULSE RESPONSE (SMALL SIGNAL)

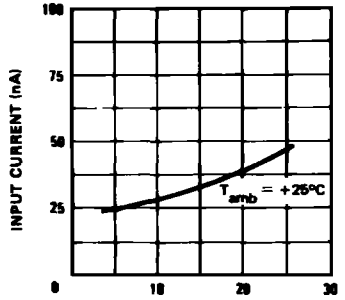


OUTPUT CHARACTERISTICS (CURRENT SOURCING)



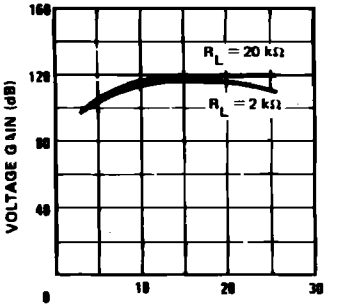
124-09.EPS

INPUT CURRENT



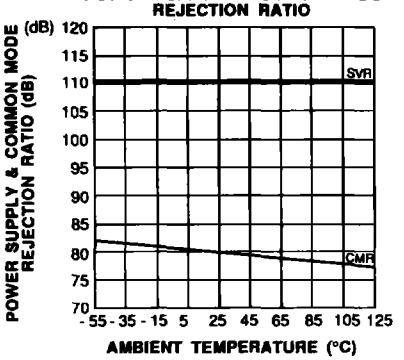
124-10.EPS

VOLTAGE GAIN



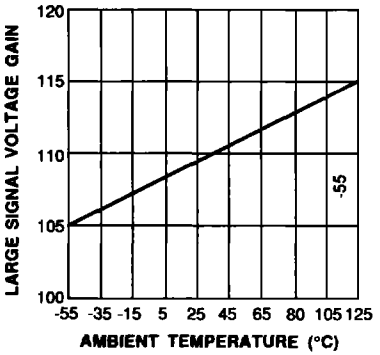
124-11.EPS

POWER SUPPLY & COMMON MODE REJECTION RATIO



124-12.EPS

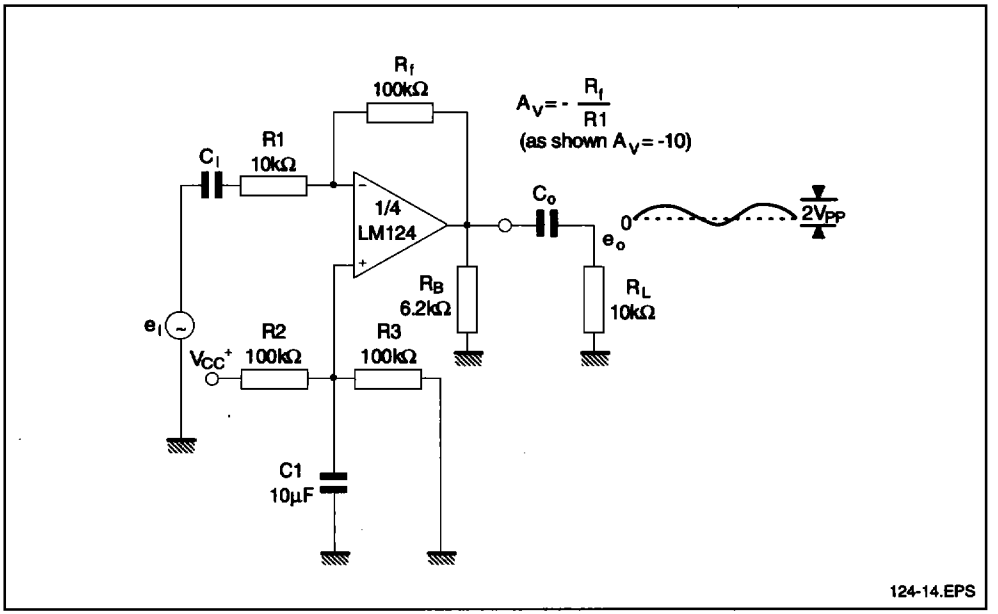
LARGE SIGNAL VOLTAGE GAIN



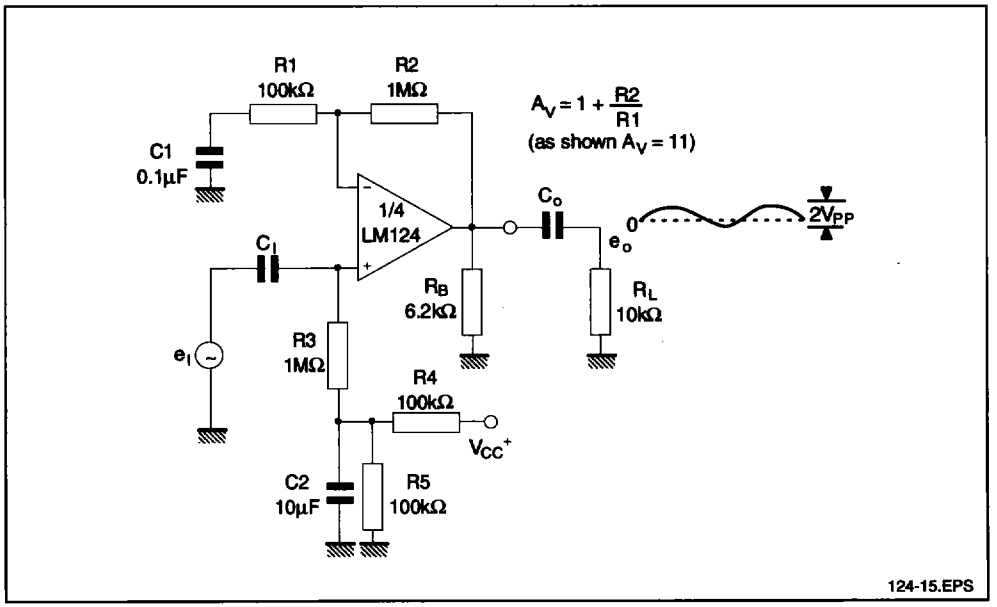
124-13.EPS

TYPICAL SINGLE - SUPPLY APPLICATIONS

AC COUPLED INVERTING AMPLIFIER

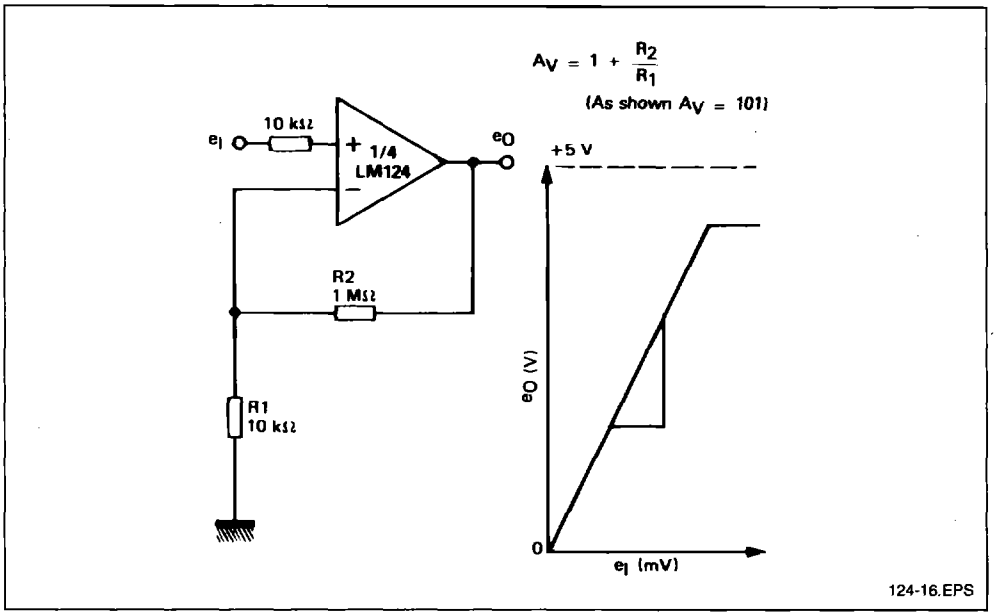


AC COUPLED NON-INVERTING AMPLIFIER

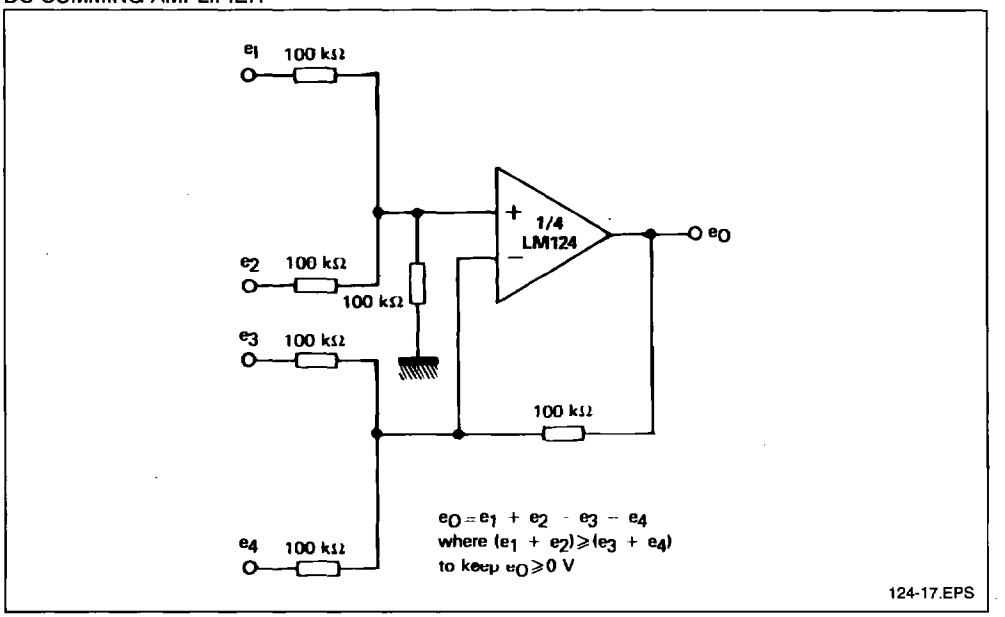


TYPICAL SINGLE - SUPPLY APPLICATIONS (continued)

NON-INVERTING DC GAIN

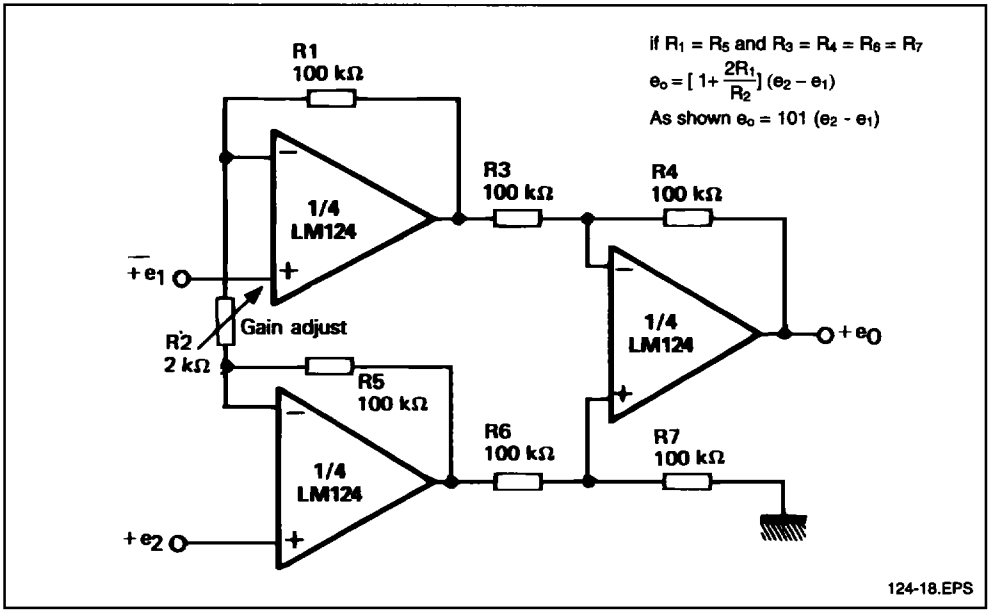


DC SUMMING AMPLIFIER

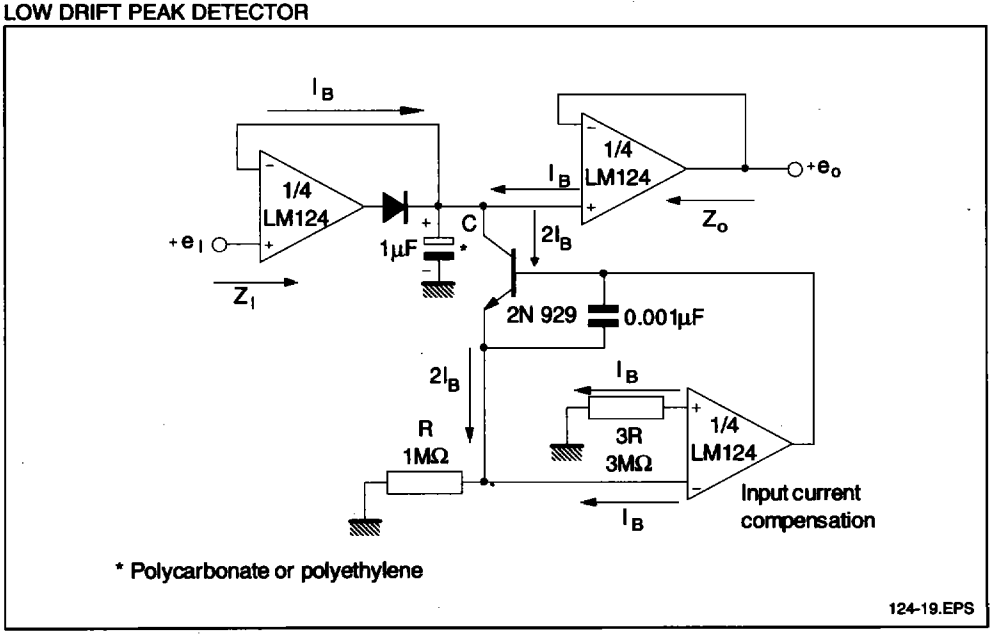


TYPICAL SINGLE - SUPPLY APPLICATIONS (continued)

HIGH INPUT Z ADJUSTABLE GAIN DC INSTRUMENTATION AMPLIFIER

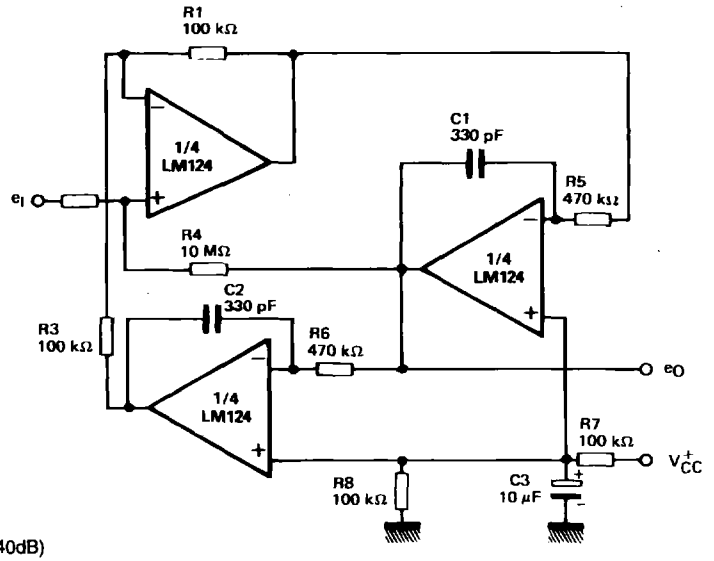


LOW DRIFT PEAK DETECTOR



YPICAL SINGLE - SUPPLY APPLICATIONS (continued)

CTIVE BANDPASS FILTER



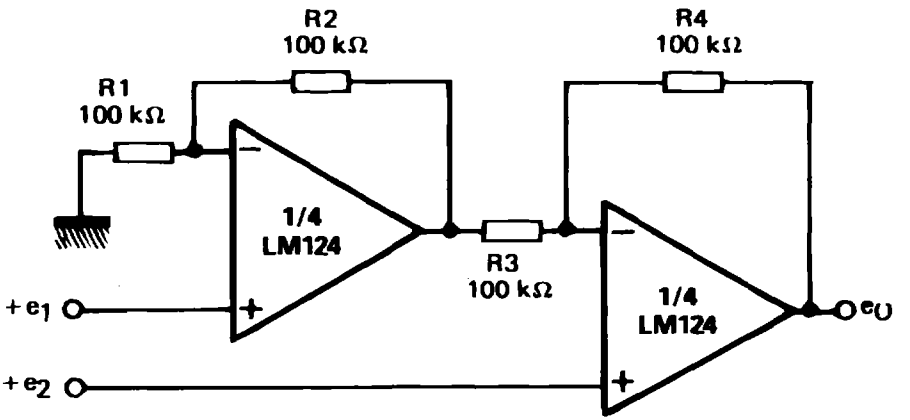
F_O = 1kHz
Q = 50
A_V = 100 (40dB)

124-20.EPS

HIG INPUT Z, DC DIFFERENTIAL AMPLIFIER

For $\frac{R_1}{R_2} = \frac{R_4}{R_3}$ (CMRR depends on this resistor ratio match) $e_o (1+\frac{R_4}{R_3})(e_2 - e_1)$

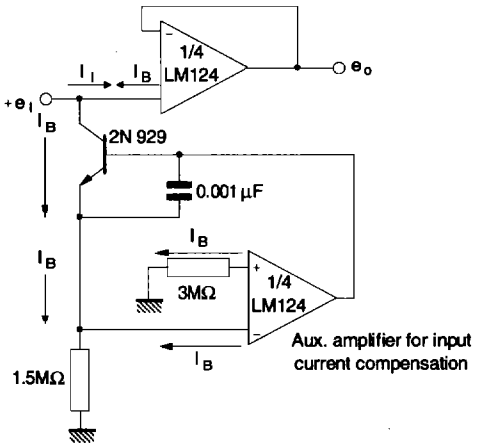
As shown $e_o = (e_2 - e_1)$



124-21.EPS

TYPICAL SINGLE - SUPPLY APPLICATIONS (continued)

USING SYMMETRICAL AMPLIFIERS TO REDUCE INPUT CURRENT (GENERAL CONCEPT)



124-22.EPS