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CHARACTERISTICS AND USAGE OF μPC1228HA

1. OUTLINE OF μPC1228HA

μPC1228HA is a silicon monolithic integrated circuit including preamplifiers for two channels which is specifically designed for a car stereo set.

This IC has a high open loop voltage gain coupled with low noise and low distortion characteristics. A design allowing a resistor with high resistance to be used in the NAB feedback circuit achieves more excellent characteristics than conventional ones even when a capacitor with low capacitance is employed in the feedback circuit. This results in reduction of the area for mounting components and cost. 8-lead SIP construction employed assures high workability.

Characteristies and usage of this IC are described below.

2. FEATURES OF μPC1228HA

1) Preamplifiers for two channels accommodated in an 8-lead SIP, which ensures compact size of a set and labor saving.
2) A high open loop voltage gain of 100 dB(TYP.) together with a design allowing a resistor with high resistance value to be used in the NAB feedback circuit which achieves excellent characteristics compared with conventional ICs even when a canpacitor of low capacitance is used.
3) Equivalent Input Noise Voltage is as low as 1.1 μV (TYP.).(R_G=2.2 kΩ, NAB)
4) Distortion level is as low as 0.05 %(TYP.). (V_O=0.3 V)
5) Wide dynamic range:V_{OM}=2.0 V(TYP.).(T.H.D.=1 %).
6) Because of DC current output available, switching circuit from a tape player to a car radio or vice versa is made simplified. I_{ODC}=1.0 mA(MAX.)
7) The IC can drive a load with low impedance:R_L=1 kΩ(MIN.)

3. EQUIVALENT CIRCUIT OF μPC1228HA

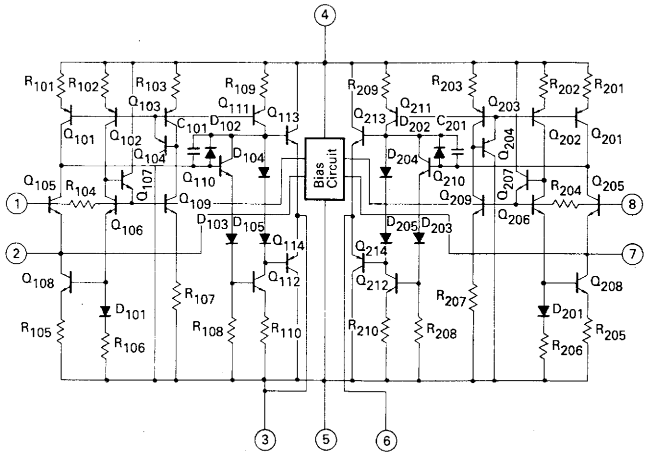


Fig.1 Equivalent Circuit

4. RATINGS OF μPC1228HA

4.1 ABOLUTE MAXIMUM RATINGS (T_a = 25 ℃)

Supply Voltage	V_{CC}	18	V
Package Dissipation	P_D	270*	mW
Operating Temperature	T_{opt}	−30 to +75	℃
Storage Temperature	T_{stg}	−40 to +125	℃

* T_a = 75 ℃

4.2 RECOMMENDED CONDITIONS (T_a = 25 ℃)

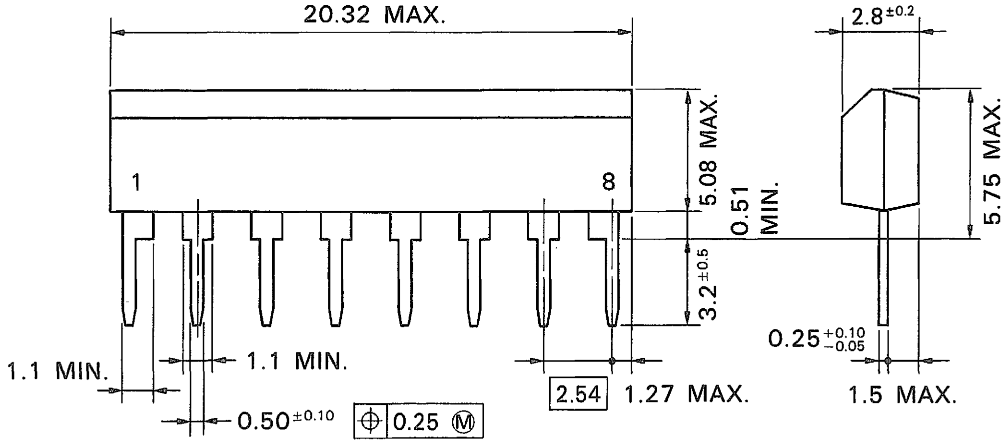
Operating supply Voltage	V_{CC}	13.2	V
Supply Voltage Range	V_{CC}	6 to 16	V
Operating Ambient Tamperature	T_a	−30 to +75	℃
Load Impedance	R_L	10 kΩ TYP.	

4.3 ELECTRICAL CHARACTERISTICS (T_a = 25 ℃, V_{CC} = 10 V, f = 1 kHz, R_L = 10 kΩ)

CHARACTERISTIC	SYMBOL	MIN.	TYP.	MAX.	UNIT	TEST CIRCUIT	TEST CONDITIONS
Quiescent Current	I_{CC}	2.5	3.3	4.8	mA	(1)	V_{in} = 0
Open Loop Voltage Gain	A_{VO}	90	100		dB	(1)	V_O = 0.3 V, f = 100 Hz
Voltage Gain	A_V		40		dB	(2)	V_O = 0.3 V, NAB
Maximum Output Voltage	V_{OM}	1.0	2.0		V	(2)	T.H.D. = 1 %, ANB
Total Harmonic Distorition	THD		0.05	0.3	%	(2)	V_O = 0.3 V, NAB
Input impedance	R_{in}	50	100		kΩ	(2)	
Equivalent Input Noise Voltage	V_{nin}		1.1	1.7	μV	(3)	R_G = 2.2 kΩ, NAB
Cross Talk	CT	−50	−65		dB	(4)	V_O = 1 V, (The other channel V_{in} = O, R_G = 2.2 kΩ)
Channel Balance	Ch.B	−0.3	0	+0.3	dB	(4)	V_O = 0.3 V

5. PACKAGE DIMENSIONS

(Unit: mm)



P8HA—254B

Fig.2 Package Dimensions

6. TEST CIRCUITS

6.1 I_{CC}, A_{VO} TEST CIRCUIT (for Ch.1)

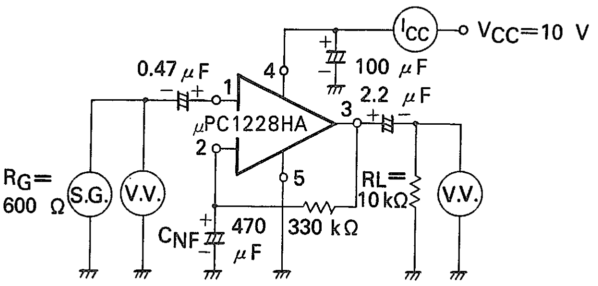


Fig.3 Test Circuit 1

6.2 A_V, V_{OM}, THD, R_{in} TEST CIRCUIT (for Ch. 1)

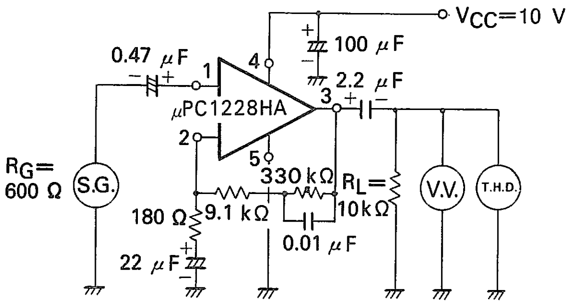


Fig.4 Test Circuit 2

6.3 V_{nin} TEST CIRCUIT (for Ch. 1)

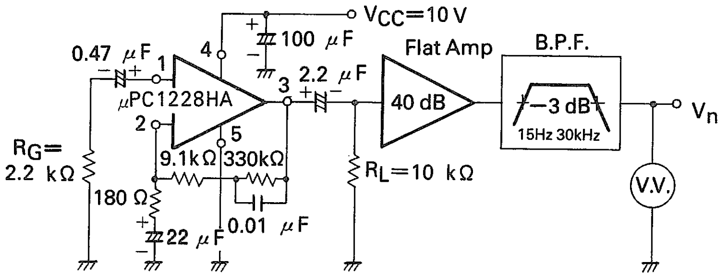


Fig.5 Test Circuit 3

NOTE: V_{nin} is calculated by V_n and amp. gain (A_V+40 dB).

6.4 CROSS TALK, CHANNEL BALANCE

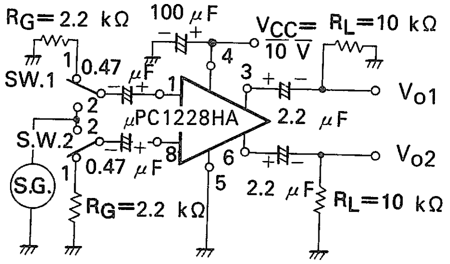


Fig.6 Test Circuit 4

NOTE 1: External components of the IC are the same as the test circuit (2).

2: Cross talk procedure

Switch position SW.1 →2,SW.2 →1,20 log V_{o2}/V_{o1}

Switch position SW.1 → 1,SW,2 →2,20 log V_{o1}/V_{o2}

3: Channel balance

Switch position SW.1 →2,SW.2 →2,20 log V_{o1}/V_{o2}

7. CONNECTION DIAGRAM OF μPC1228HA

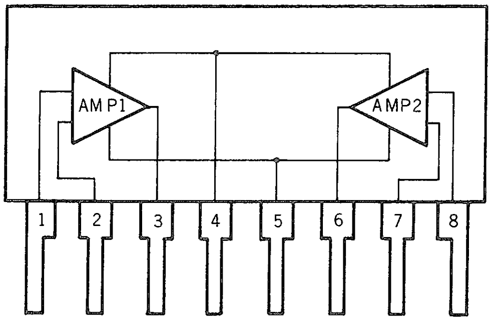


Fig.7 Block Diagram

Table 1. Pin Connection

Pin No.	Electrical connection
1	Input 1
2	Negative feed back 1
3	Output 1
4	Power supply: $+V_{CC}$
5	Ground
6	Output
7	Negative feed back 2
8	Input 2

8. EXPLANATION OF EXTERNAL COMPONENTS

8.1 TYPICAL APPLICATION CIRCUIT

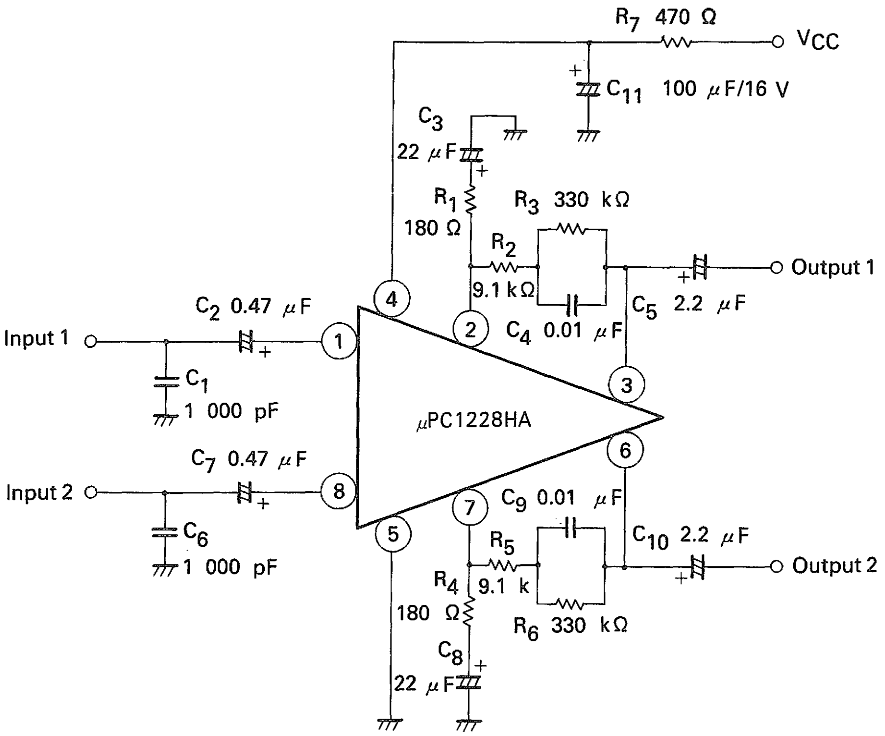


Fig.8 Typical Application Circuit

8.2 PURPOSE AND RECOMMENDED VALUES

C_1 and C_6 are used for preventing interference by external noises and self-oscillation occurring when a circuit has a signal source of high resistance and should be preferably around 1 000 pF.

C_2 and C_7 are coupling capacitors for input signals.

A preamplifier with NAB characteristics has high voltage gain for low frequency signals, and thus 1/f noises of the IC itself are emphasized as output noises:high impedance of the capacitance in low frequency results in increased output noise voltages because of the dependence of 1/f noises on signal source resistance. Therefore, impedance of the capacitance should be sufficiently lower than that of the signal source. On the other hand, C_2 and C_7 over 2.2 μF extends operation starting time. Accordingly, around 0.47 μF is desirable.

C_3 and C_8 for negative feedback circuit affect the lower cut off frequency. (See Fig.22.) As C_3 and C_8 with large capacitance also extends operation starting time, 22 μF is preferable.

The frequency response and gain of the preamplifier depends on C_4, R_1, R_2, and R_3 (or C_9, R_4, R_5, and R_6). Time constants for obtaining a standard NAB characteristics are as follows.

Table 5 Time Constans for a Standard NAB Characteristics

Tape Speed Time constant	9.5 cm/s	4.75 cm/s
C_4 $(R_2 + R_3)$	3 180 μs	1 590 μs
C_4R_2	90 μs	120 μs

C_{11} is a bypass capacitor on the power supply line.
It reduces ripple component by the ratio of the impedance of to R_7.
A 100 μF capacitor should be attached as close to the power supply terminal(Pin④) and GND terminal(Pin⑤) as possible. R_7 with a too high registance value degrades the supply voltage characteristic while that with a too low registance degrades the filtering effect, and therefore the value of around 470 Ω is recommended.

C_5 and C_{10} are coupling capacitors for output signals, and should preferably be of 2.2 μF.

8.3 ELEMENTS FOR NEGATIVE FEEDBACK CIRCUIT AND DETERMINATION OF GAIN

A DC feedback current flows through negative feedback elements R_2 and R_3 (or R_5 and R_6) to provide an output voltage at the terminal ③ (⑥) which is given as follows:

$$V_{ODC} \fallingdotseq (R_2 + R_3) \times 9 \times 10^{-6} + 0.7 \text{ (V)} \cdots (1)$$

Consequently, the maximum output level is obtained under the supply voltage of V_{CC} by determining values of R_2 and R_3 so that the voltage V_{ODC} is 1/2 V_{CC}. (See Fig. 20.)

$$V_{ODC} \fallingdotseq 1/2\ V_{CC}$$

$$\therefore R_2 + R_3 \fallingdotseq (1/2\ V_{CC} - 0.7) / (9 \times 10^{-6})\ (\Omega) \cdots (2)$$

In addition to the above relation, however, degradation in supply voltage characteristics at low temperature should be taken into account for determining R_2 and R_3. Usually, around 300 kΩ is suitable as the resistance value of R_3, or around 200 kΩ when the voltage at the pin ④ is approximately 6 V. (See Fig.21.) Determination of the gain is accomplished by adjusting R_1 (or R_4) while keeping C_4, R_2, and R_3(C_9, R_5 and R_6) constant in their values. (See Fig.23.)

As for an amplifier with negative feedback applied, the gain generally follows an equation $A_V = A_{VO}/(1+A_{VO}\beta)$.

Taking the impedance of a feedback circuit as Z,
$A_V = Z/R_1$ when $1 \ll A_V \ll A_{VO}$. (where $\beta = R_1/(R_1 + Z)$.)
Therefore, R_1 is determined by $R_1 = Z/A_V$. (Where A_V and Z respectively the gain and impedance of the feedback element employed when f = 1 kHz.)

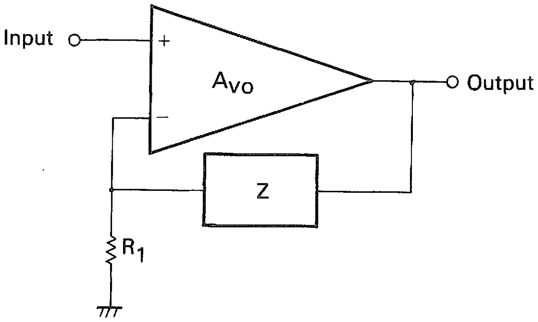


Fig.9 An Amplifier with Negative Feedback

8.4 EXAMPLES OF NEGATIVE FEEDBACK CIRCUIT

Table 3 Time Constants for NAB

Tape Speed Time constant	9.5 cm/s	4.75 cm/s
$C_4(R_2+R_3)$	3 180 μs	1 590 μs
C_4R_2	90 μs	120 μs

(1) When the tape speed is 9.5 cm/s

Taking C_4 as 0.01 μF gives $R_2 = 9$ kΩ. Therefore, $R_3 = 309$ kΩ, $R_2 = 9.1$ kΩ and $R_3 = 330$ kΩ should be employed. This causes $Z = R_2 = R_3 \;//\; (1/j\omega C_4) = 18.7$ kΩ.

(2) When the tape speed is 4.75 cm/s

Taking C_4 as 0.004 7 μF gives $R_2 = 25.5$ kΩ and $R_3 = 313$ kΩ. Therefore, $R_2 = 27$ kΩ and $R_3 = 330$ kΩ should be employed, which give the impedance $Z = 34.3$ kΩ.

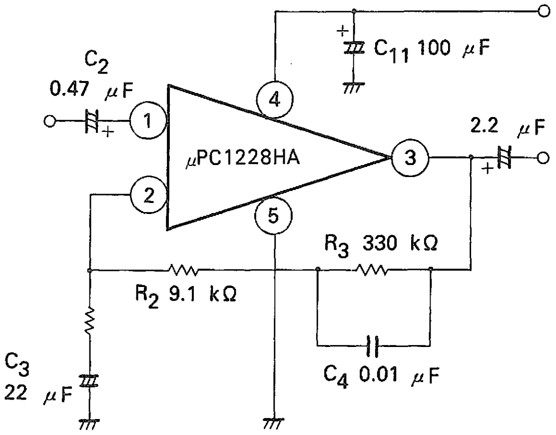


Fig.10 Example in the Case of the Tape Speed of 9.5 cm/s

A_V	35	40	45	dB
R_1	330	180	100	Ω

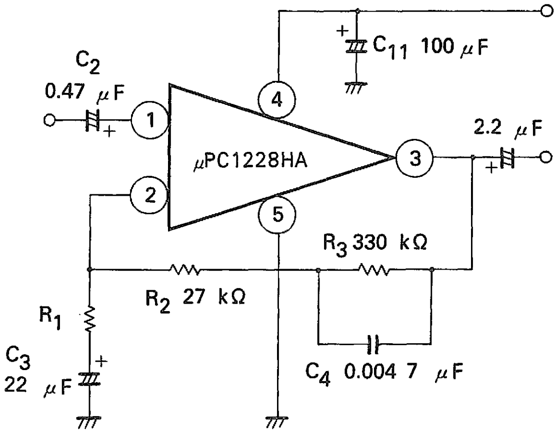


Fig.11 Example in the case of the Tape Speed of 4.75 cm/s

A_V	35	40	45	dB
R_1	620	330	180	Ω

8.5 SUMMARY

Table 4 Summary of Usage of External Components

External Components	Purpose of use	Recommended value	When smaller than recommended value	When larger than recommended value
C_1 (C_6)	• Protection from ignition noises, radio interference and self oscillation	1 000 pF	• Liable to be influenced by noises	• Degradation in high frequency response
C_2 (C_7)	• Coupling of input signals	0.47 μF	• Degradation in low frequcy response • Increase in output noises	• Later start of operation
C_3(C_8)	• Elimination of DC component in a feedback circuit	22 μF	• Degradation in low frequency response • Sooner start of operation	• Improvement in low frequency response • Later start of operation
R_1 (R_4)	• Determination of the gain of an equalizer	180 Ω	• Higher gain	• Lower gain
R_2(R_5) R_3 *(R_6) C_4 (C_9)	• Determination of frequency response characteristic of an equalizer	9.1 kΩ 330 kΩ* 0.01 μF	• Higher turnover frequency * V_{OM} lowers * Supply voltage characteristic is improved	• Lower turn over frequency * V_{OM} is raised. * Supply voltage characteristic is degraded.
C_5 (C_{10})	• Coupling of output signals	2.2 μF	• Degradation in low frequency response	• Improvement in low frequency response
R_7	• Elimination of ripple components in supply voltage R_7 sould be 220 Ω or larger to secure stability when the device is connected to a power amplifier When R_7 is lower than 100 Ω, C_{11} should be 220 μF or larger.	470 Ω	• Decrease in SVR Improvement in supply voltage characteristic	• Improvement in SVR • Degradation in supply voltage characteristic
C_{11}	• Elimination of ripple component in supply voltage	100 μF	• Decrease in SVR	• Improvement in SVR

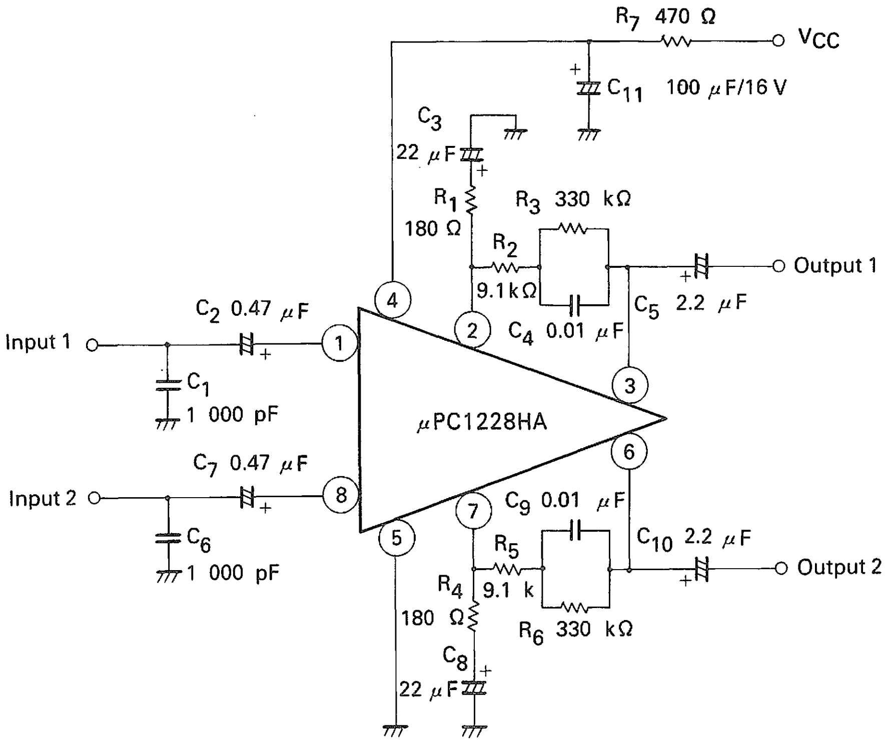


Fig. 12 External Components

9. Application to Signal Switching Circuits

The output stage of the μPC1228HA is an SEPP circuit capable of driving a load with low impedance as well as delivering output DC current, simplifying a signal switching circuit to be connected by constituting a the circuit as shown on Fig.13.

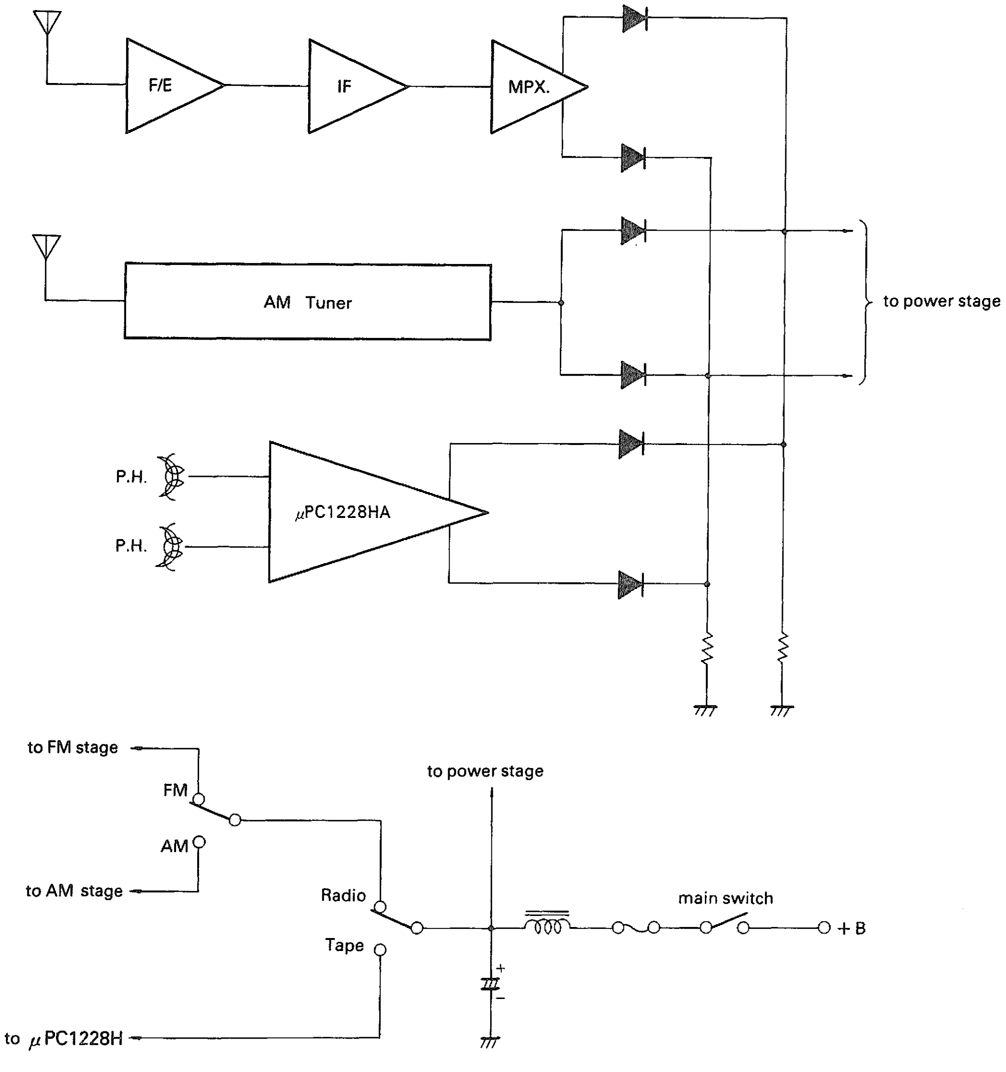


Fig.13 Signal Switching Circuit

10. TYPICAL CHARACTERISTICS

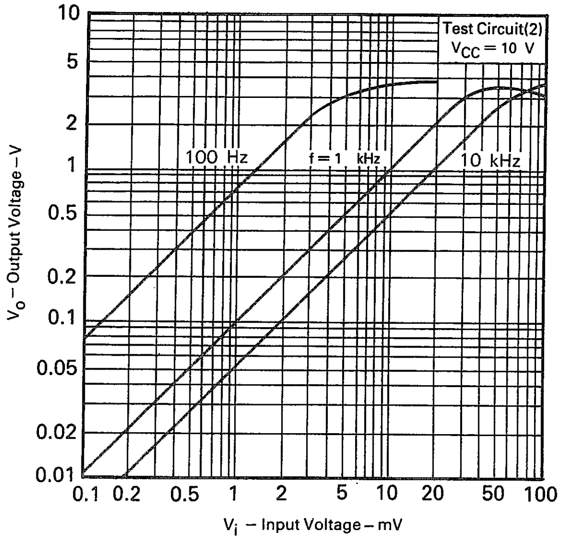


Fig.14 OUT PUT VOLTAGE vs. INPUT VOLTAGE

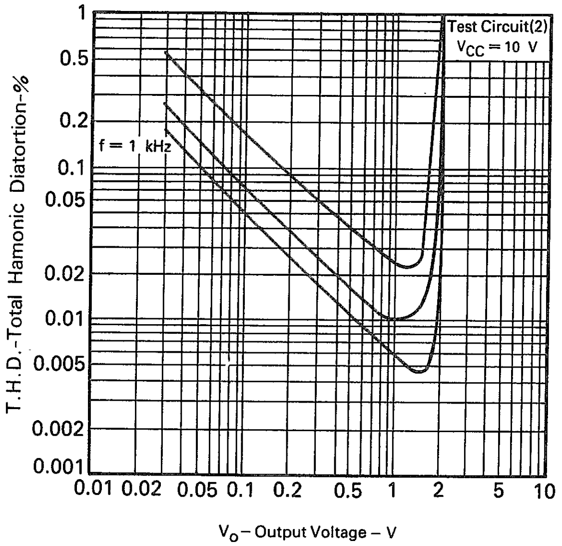


Fig.15 TOTAL HARMONIC DISTORTION vs. OUTPUT VOLTAGE

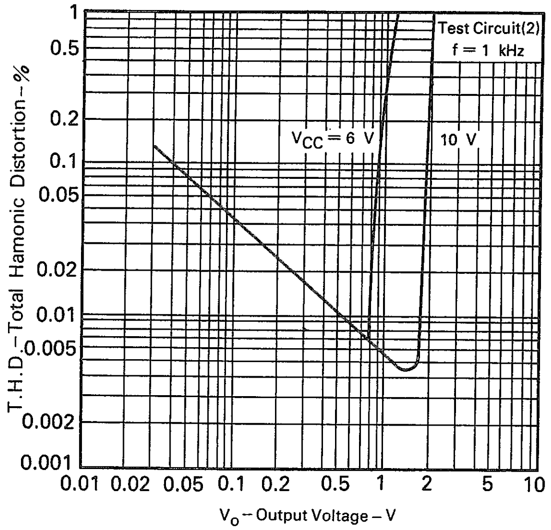


Fig.16 TOTAL HARMONIC DISTORTION vs. OUTPUT VOLTAGE

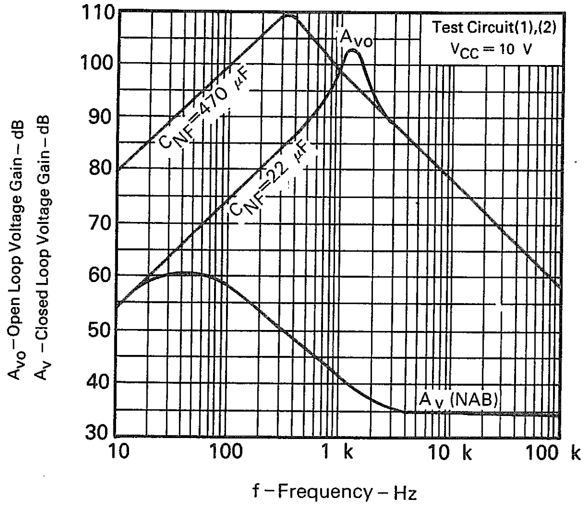


Fig.17 VOLTAGE GAIN vs. FREQUENCY

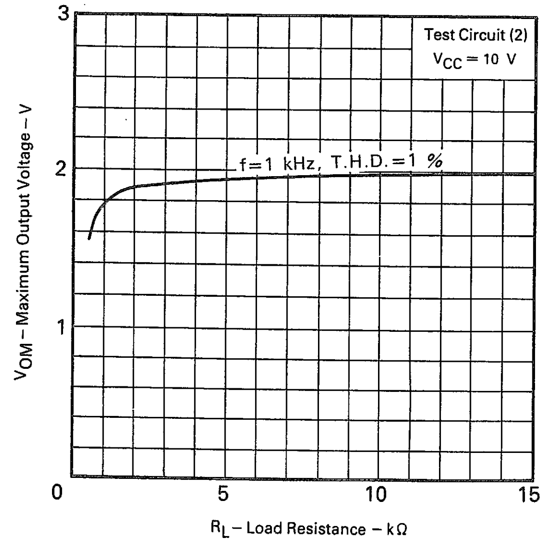


Fig.18 MAXIMUM OUTPUT VOLTAGE vs. LOAD RESISTANCE

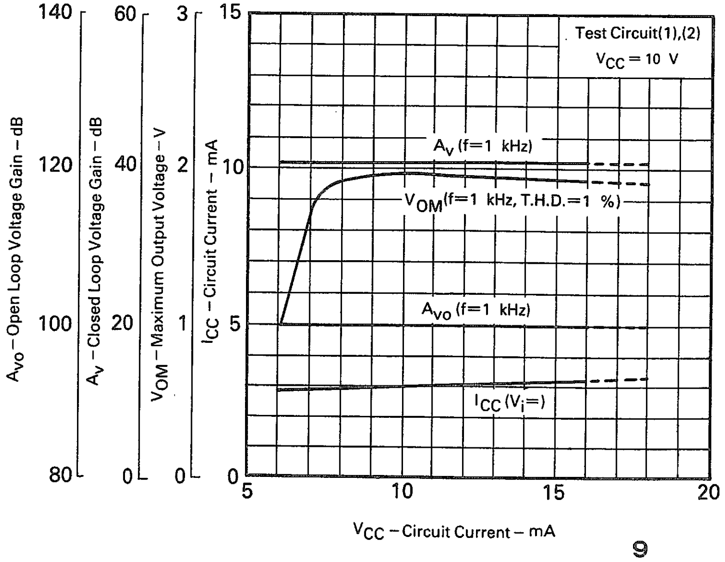


Fig.19 CIRCUIT CURRENT, MAXIMUM OUTPUT VOLTAGE, VOLTAGE vs. SUPPLY VOLTAGE

Fig.20 Maximum Output Voltage vs. Feedback Resistance

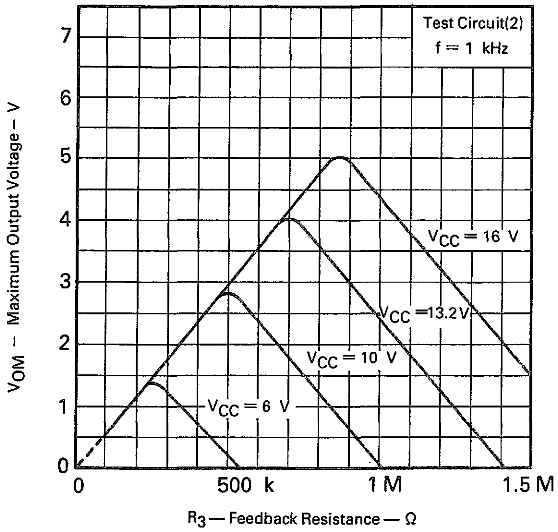


Fig.21 Maximun Output Voltage vs. Supply Voltage

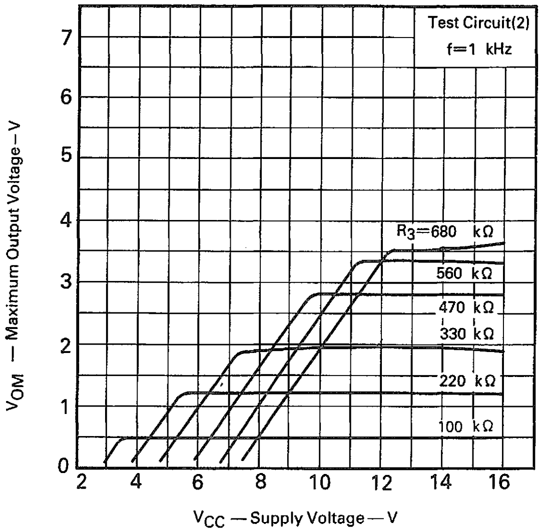


Fig.22 Voltage Gain vs. Frequency

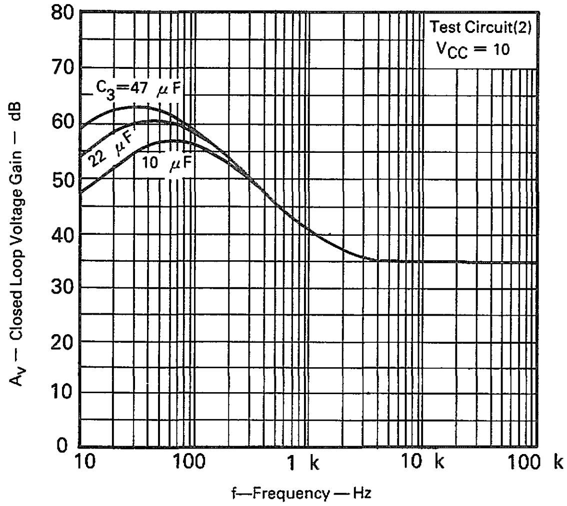


Fig.23 Voltage Gain vs. Frequency

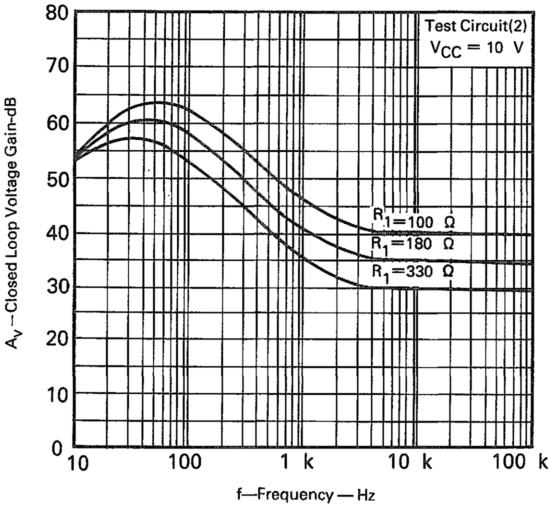


Fig.24 Equivalent Input Noise Voltage vs. Signal Sourse Resistance

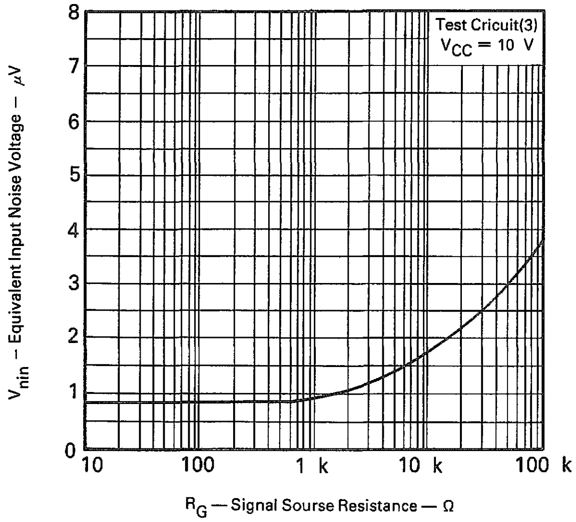


Fig.25 Cross Talk vs. Frequency

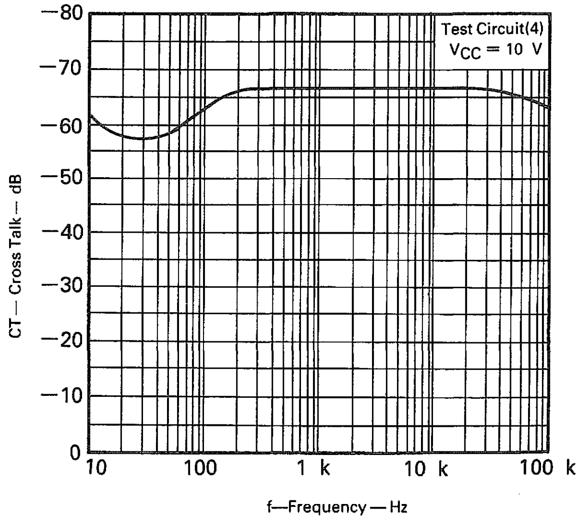


Fig.26 Open Loop VoltageGain, Maximum Output Voltage, Circuit vs. Ambient Temperature

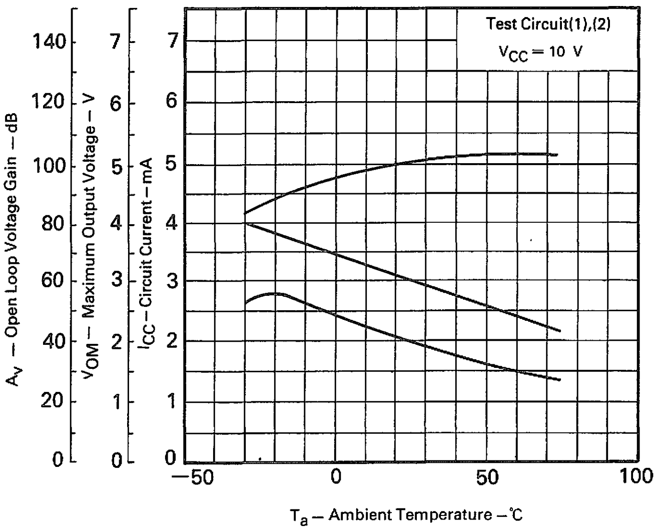
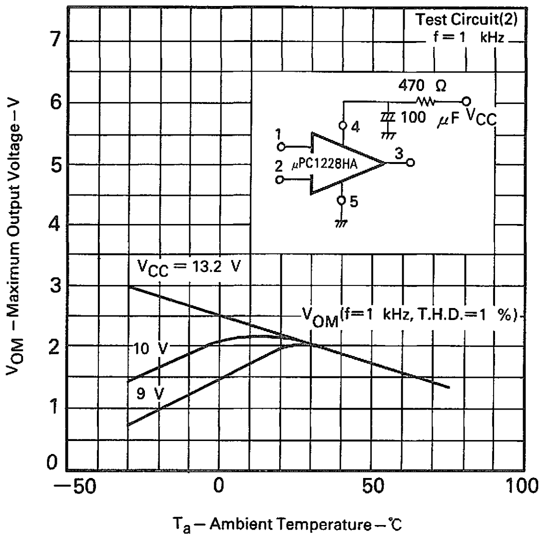


Fig.27 Maximum Output Voltage vs. Ambient Temperature



11. EXAMPLE OF APPLICATION CIRCUIT

11.1 APPLICATION 1 (NAB EQ, V_{CC}=8~17 V, V_{OM}=2 V)

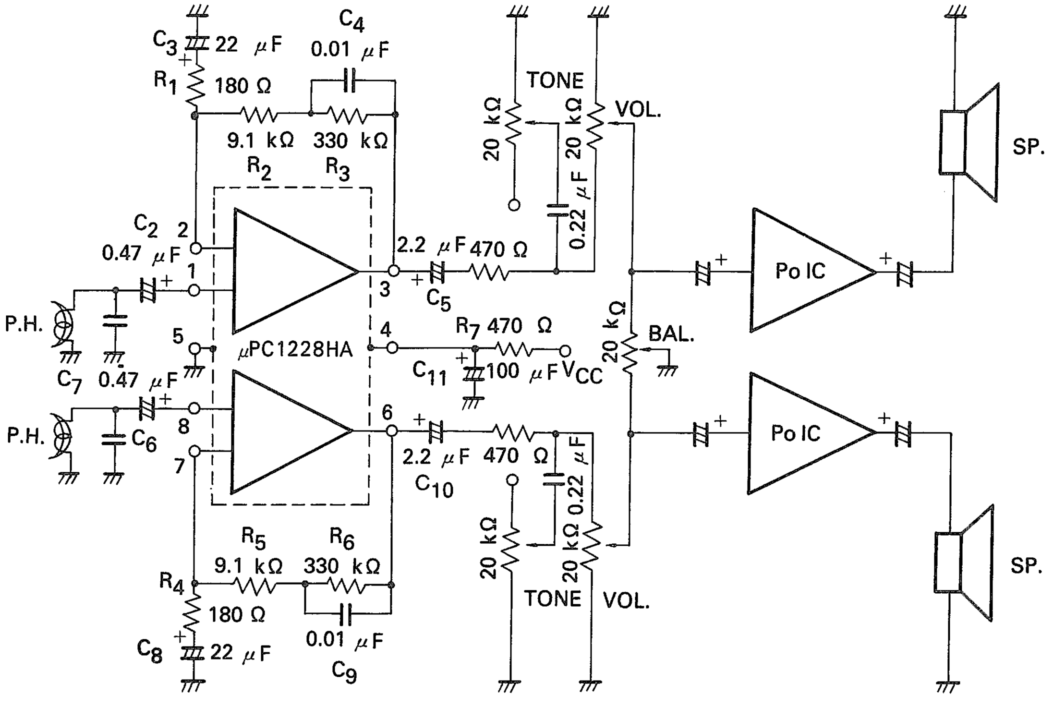
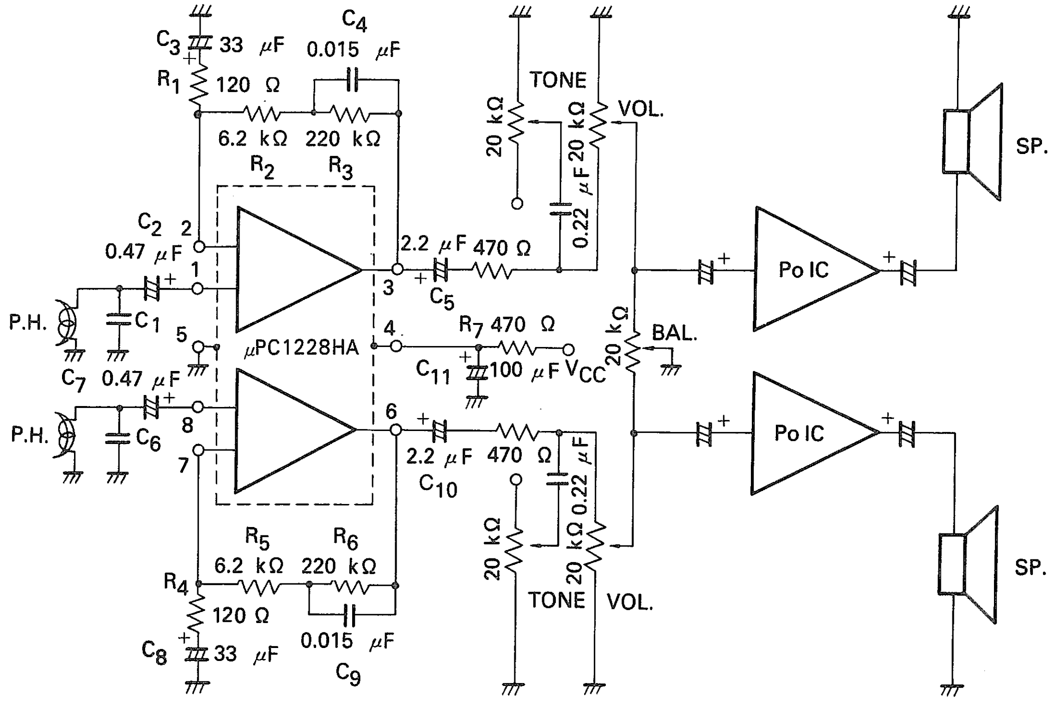


Fig.28 Application Circuit 1

11.2 APPLICATION 2 (NAB EQ, V_{CC}=6~17 V, V_{OM}=1.2 V)



* When supply voltage of pin 4 is down to 6 V, please use TYPICAL APPLICATION 2.

Fig.29 Application Circuit 2

12.3 APPLICATION 3 (RIAA EQ, V_{CC}=8~18 V, V_{OM}=2 V)

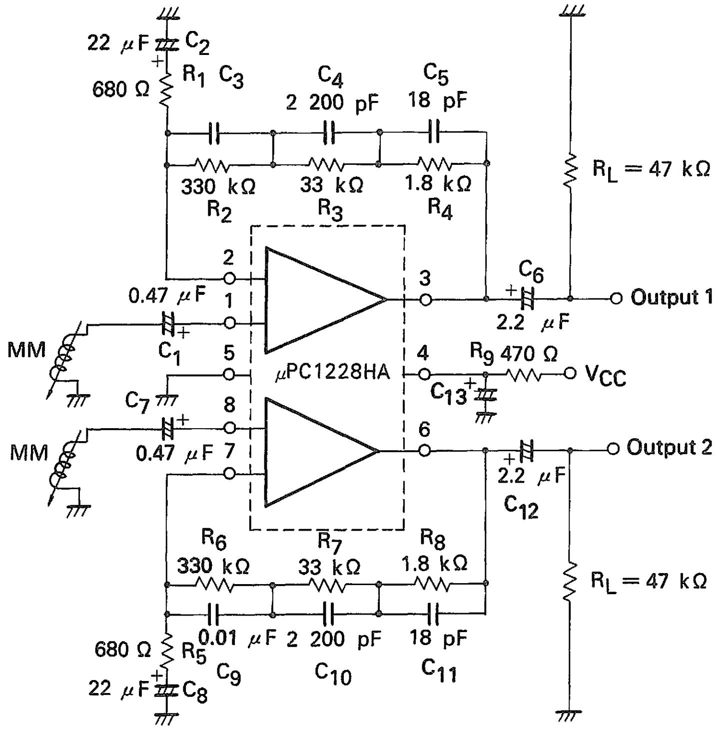


Fig.30 Application Circuit 3

13. TYPICAL PRINTED CIRCUIT BOARD PATTERN AND COMPONENT LAYOUT

(Copper Foil Side)

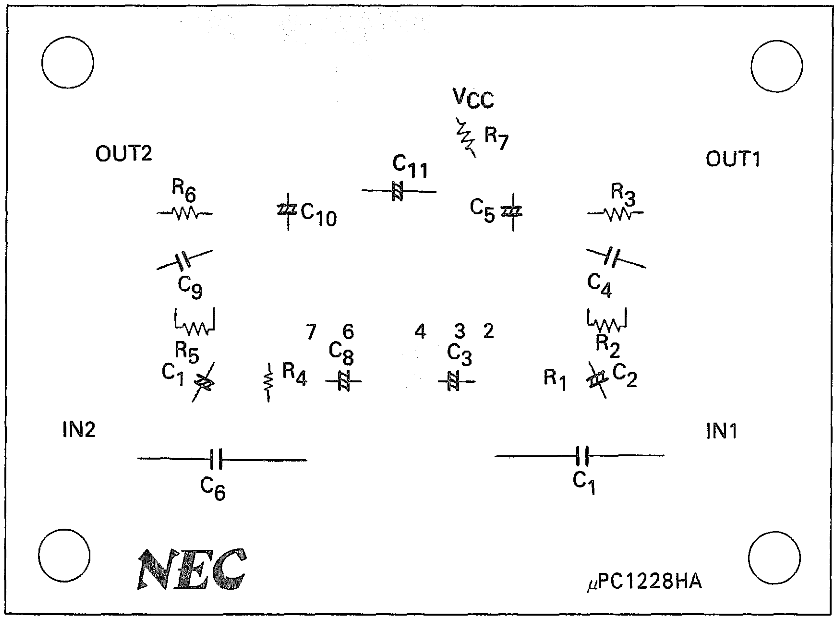


Fig.31 Printed Circuit Board

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