SONY® CXA1198AP

Stereo Cassette Deck Recording Equalizer

Description

CXA1198AP is a bipolar IC developed for recording equalizers used in analog cassette decks. A built-in filter circuit dispenses with external parts such as the inductor (coil).

External resistors permit the independent setting of the six parameters required for the recording equalizer.

Features

- Inductor (coil) no use
- 6 parameters for recording equalizer: gain, peaking frequency, Q, peak gain, medium band equalizing gain and medium band equalizing frequency can be independently set using resistors.
- 2 built-in channels
- Compact package (16 pin DIP)

Structure
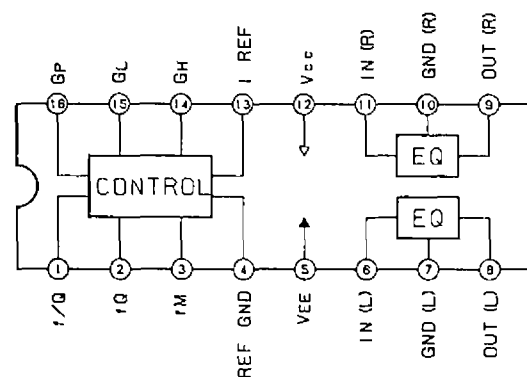
Bipolar silicon monolithic IC

Applications

- Recording equalizer amplifier for analog cassette decks.

Absolute Maximum Ratings (Ta=25°C)

- Supply voltage   Vcc   17   V
- Storage temperature   Tstg   −55 to +150   °C
- Operating temperature   Topr   −20 to +75   °C
- Allowable power   Po   900   mW
  dissipation

Recommended Operating Conditions (Ta=25°C)

- Supply voltage   Vcc, VEE   ±4.0 to ±7.5   V
                                       (Dual supply)
                     Vcc   8.0 to 15.0   V
                                       (Single supply)

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16 pin DIP (Plastic)

Block Diagram and Pin Configuration (Top View)

GP (16)   GL (15)   GH (14)   I REF (13)   Vcc (12)   IN (R) (11)   GND (R) (10)   OUT (R) (9)

CONTROL   EQ   EQ

I/Q (1)   rQ (2)   rM (3)   REF GND (4)   VEE (5)   IN (L) (6)   GND (L) (7)   OUT (L) (8)

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Pin Description and Equivalent Circuit

Ta=25°C, Vcc=7.0V, VEE=−7.0V, no signal

No.	Symbol	DC voltage	Equivalent circuit	Description
1 2 3 13 14 15 16	f/Q fQ fM IREF GH GH GP	1.2V		Current input pin that sets respective parameters. Attaching a resistor to GND generates the current that sets respective parameters.
4	REF GND	GND		Dual supply : GND Single supply : GND
5	VEE	−7.0V		Dual supply : VEE Single supply : GND
6 11	IN (L) IN (R)	0V		Input pin Input impedance : 100kΩ
7 10	GND (L) GND (R)	0V		Dual supply : GND Single supply : $\dfrac{Vcc}{2}$
8 9	OUT (L) OUT (R)	0.5V		Output pin
12	Vcc	7.0V		Power supply pin : Vcc

Electrical Characteristics

Ta=25°C, Vcc=7.0V, VEE=−7.0V

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
Current consumption	Icc		11.0	17.5	26.0	mA
Reference input level	VIN		−28.0	−26.0	−24.0	dBm
Reference output level	VOUT		−	−5.0	−	dBm
S/N ratio	SN(AWTG)	Rg=5kΩ, "A"-WTG filter	60	63	−	dB
Signal handling	SH	RL=3.6kΩ, 1kHz, THD=1%	17.0	18.5	−	dB
Total harmonic distortion rate	THD	1kHz, 0dB	−	0.2	0.5	%
Output offset voltage	VOFF		−0.5	0.5	1.0	V

Variable Width of Respective Parameters

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
fM medium band correction frequency	fM		0.63	2.0	6.3	kHz
fo peaking frequency	fo		10	20	40	kHz
Peaking Q	Q		2	4	6	
GL low band gain	GL		−3.0	0.0	5.0	dB
GH medium band gain	GH		−8.0	0.0	12.0	dB
GP peaking gain	GP		5.0	15.0	25.0	dB

Setting Error of Respective Parameters

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
fM medium band correction frequency	ΔfM		−10	0	10	%
fo peaking frequency	Δfo		−10	0	10	%
Peaking Q	ΔQ		−5	0	5	%
GL low band gain	ΔGL	Setting error	−0.5	0	0.5	dB
GH medium band gain	ΔGH	refer to GL	−0.8	0	0.8	dB
GP peaking gain	ΔGP	refer to GL	−1.2	0	1.2	dB
Input impedance	ZIN	Pin 6, Pin 11	65	100	150	kΩ

Note) Unless otherwise specified, settings for GL, GH, GP, FM, FP, and Q are characteristics provided when the typical value is set.
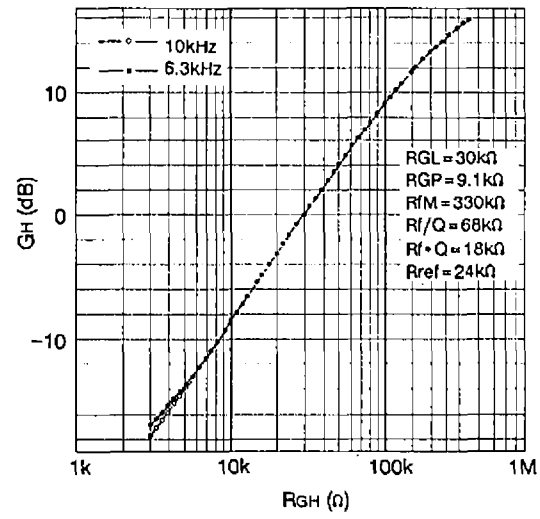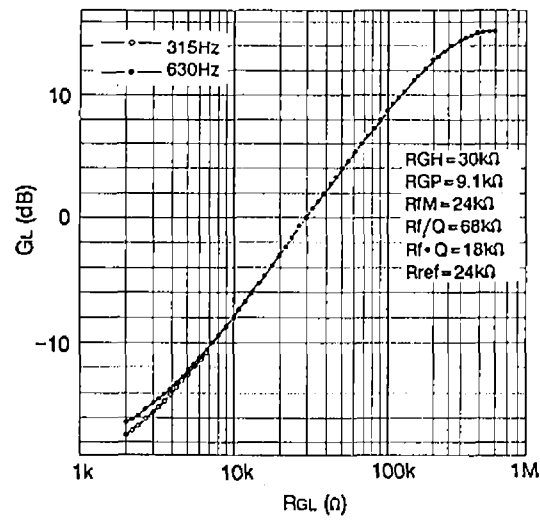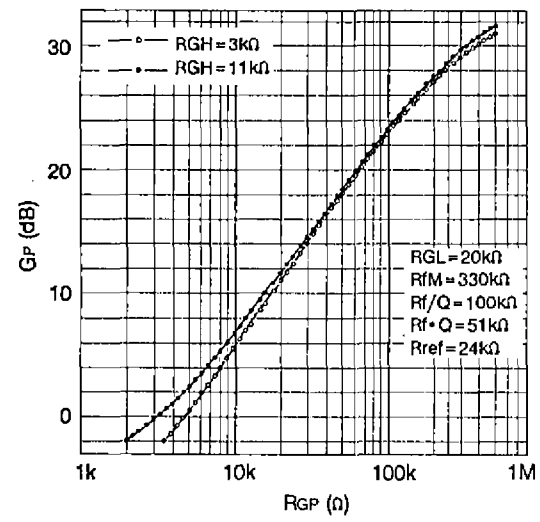
Electrical Characteristics Test Circuit

Vcc

(A) DC Ammeter

100μ/25V

5.1k

S20

22μ (BP)

S22

100μ/25V

S24

1k

3.6k

100

4.7μ (BP)

12 11 10 9

Rch S27

Lch

DC Voltmeter

Rch S26

Lch

Noise Filter

OUT

IN

S28

5 6 7 8

22μ (BP)

S23

5.1k

S23

100μ/25V

4.7μ (BP)

100μ/25V

100

3.6k

S25

1k

(A) DC Ammeter

VEE

AC Voltmeter

Distortion Analyzer

Oscilloscope
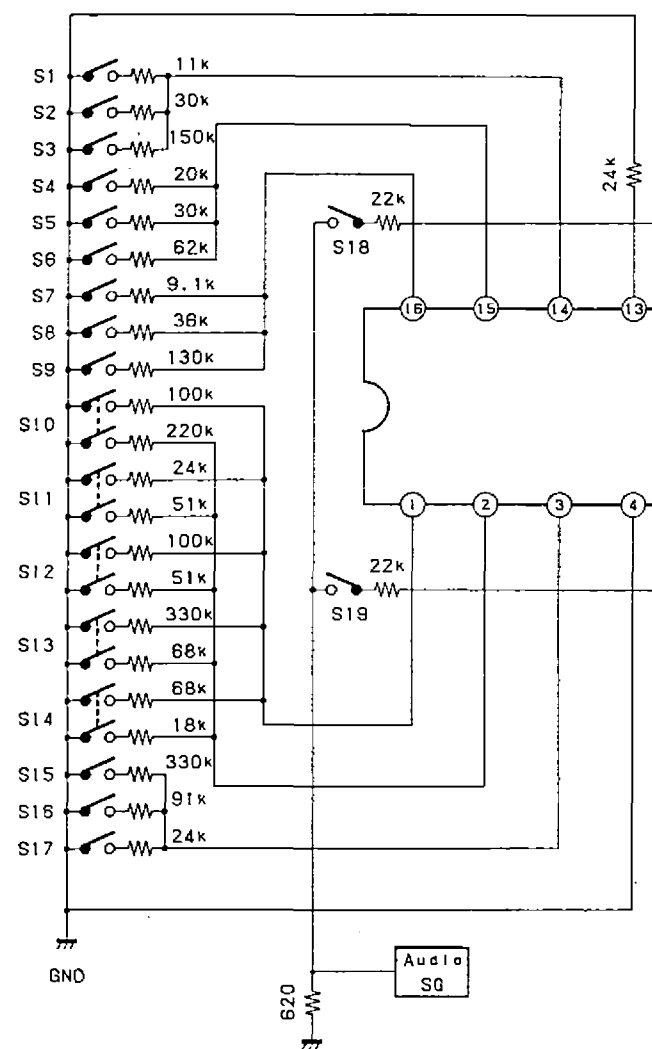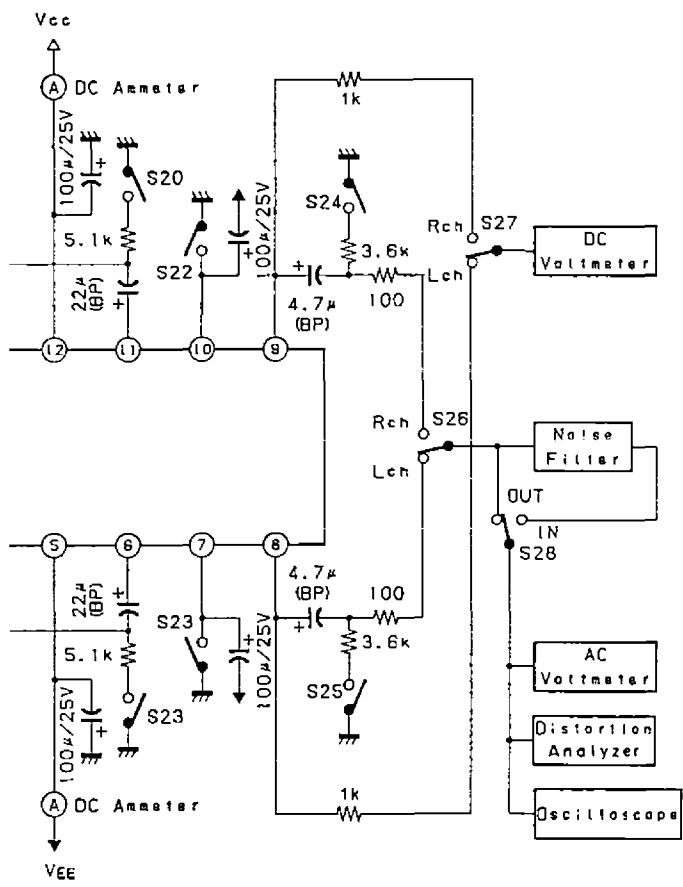
Parameters Characteristics vs. Respective Resistance

RGL vs. GL (gain) characteristics (refer to RGL=30 kΩ)

Legend:
- 315Hz
- 630Hz

RGH=30kΩ
RGP=9.1kΩ
RfM=24kΩ
Rf/Q=68kΩ
Rf•Q=18kΩ
Rref=24kΩ

(Axes: GL (dB) vs RGL (Ω))

RGH vs. GH (gain) characteristics (refer to GL)

Legend:
- 10kHz
- 6.3kHz

RGL=30kΩ
RGP=9.1kΩ
RfM=330kΩ
Rf/Q=68kΩ
Rf•Q=18kΩ
Rref=24kΩ

(Axes: GH (dB) vs RGH (Ω))

RGP vs. GP (gain) characteristics (refer to GL)

Legend:
- RGH=3kΩ
- RGH=11kΩ

RGL=20kΩ
RfM=330kΩ
Rf/Q=100kΩ
Rf•Q=51kΩ
Rref=24kΩ

(Axes: GP (dB) vs RGP (Ω))

RfM vs. fM (cut off frequency) characteristics

RGL=62kΩ
RGH=11kΩ
RGP=9.1kΩ
Rf/Q=68kΩ
Rf•Q=18kΩ
Rref=24kΩ

(Axes: fM (Hz) vs RfM (Ω))

Rf/Q vs. f/Q (cut off frequency) characteristics

RGL=20kΩ
RGH=11kΩ
RGP=130kΩ
RfM=330kΩ
Rref=24kΩ

(Axes: f/Q (Hz) vs Rf/Q (Ω))

Rf•Q vs. f•Q (cut off frequency) characteristics

RGL=20kΩ
RGH=11kΩ
RGP=130kΩ
RfM=330kΩ
Rref=24kΩ

(Axes: f•Q (Hz) vs Rf•Q (Ω))

Electrical Characteristics

Load characteristics

Legend:
- ○— 1kHz
- ●— 315Hz

Maximum output level (dB) vs Load RL (Ω)

Vcc, VEE= ±7.0V

RGL=30kΩ
RGH=30kΩ
RGP=36kΩ
Rref=24kΩ
RIM=91kΩ
Rf/Q=100kΩ
Rf•Q=51kΩ

THD=1%
0dB=5dBm

Total harmonic distortion

Legend:
- ●— 315Hz
- ○— 1kHz
- ×— 3kHz
- ●— 6.3kHz
- ○— 10kHz
- ●— 15kHz

THD + N (%) vs Output level (dB)

Vcc, VEE= ±7.0V

RGL=30kΩ
RGH=30kΩ
RGP=36kΩ
Rref=24kΩ
RIM=91kΩ
Rf/Q=100kΩ
Rf•Q=51kΩ

0dB=−5dBm

Operation

CXA1198AP obtains the frequency characteristics necessary for the recording equalizer by means of the circuit block shown in Fig. 1.
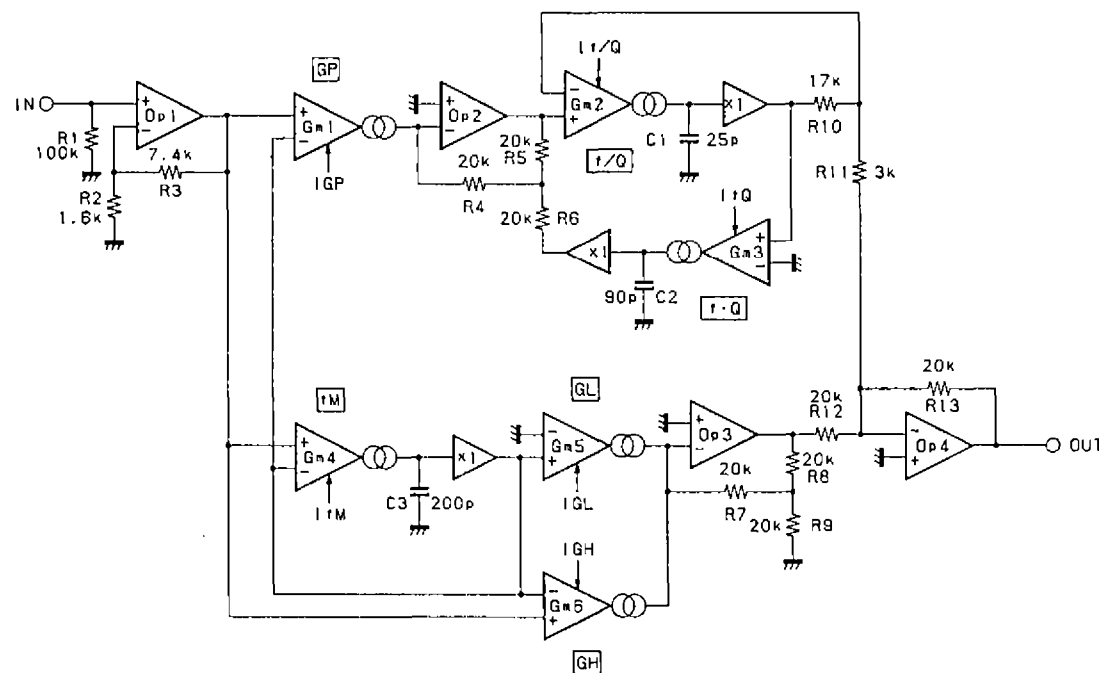
Fig. 1

Gm1 through Gm6 in the figure are transconductance amplifiers and Op1 through Op4 are operational amplifiers.

Transconductance amplifiers change voltage into current conversion coefficient using control currents (IGL, IGH, IGP, IFM, IF/Q, IFQ). When a capacitor is connected to the load, those transconductance amplifiers turn into variable integrators. When a resistor is connected to the load they became variable gain amplifiers.
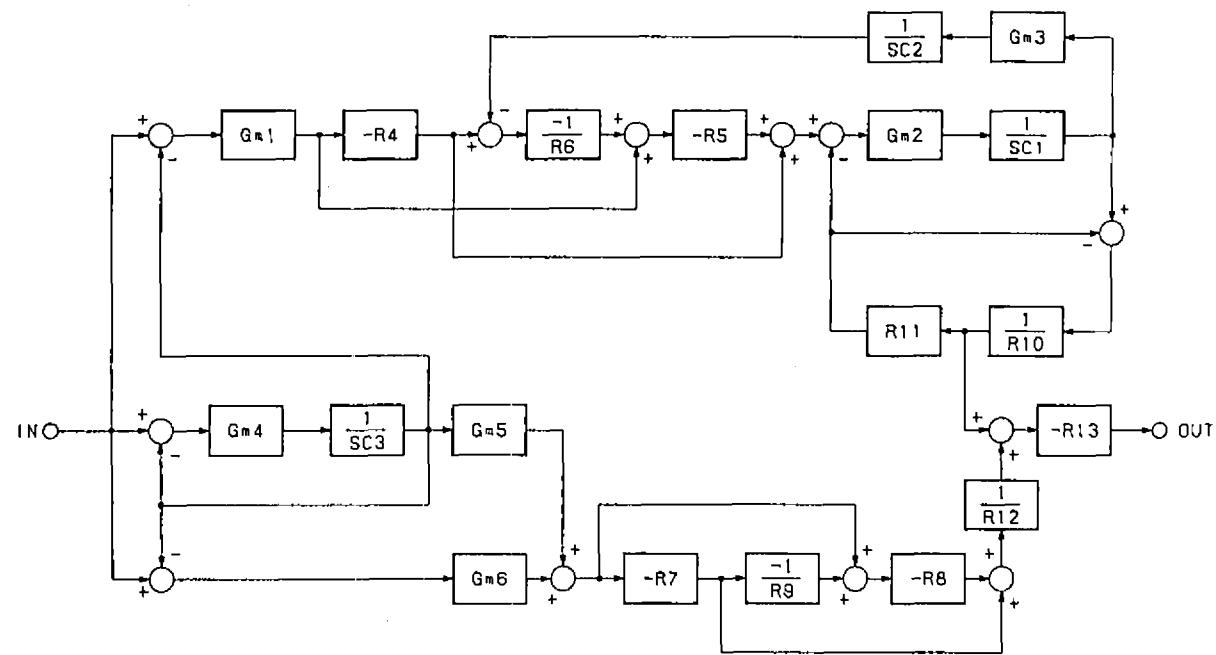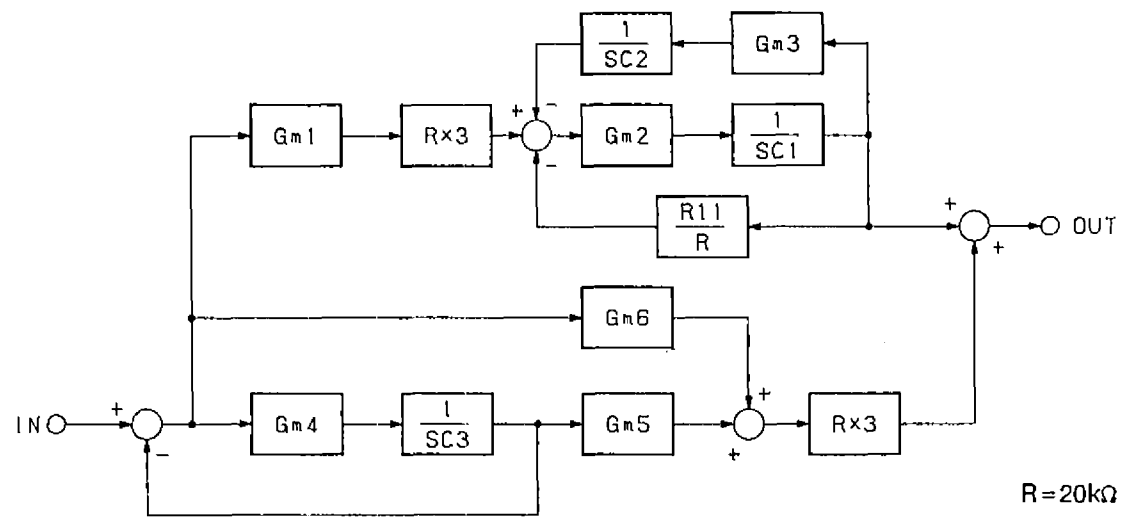
Fig. 2   Signal block diagram

Fig. 3   Signal block diagram (simplified of Fig. 2)

R=20kΩ

The transfer function is as follows for the recording equalizer circuit.

When the block diagram in Fig. 3 is divided to low pass filter, high pass filter, and band pass filter and respective transfer function are GLPF (S), GHPF (S), and GBPF (S):

$$GLPF(S) = \frac{\dfrac{Gm4}{C3}}{S + \dfrac{Gm4}{C3}} \cdot 3 \cdot R \cdot Gm5 \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (1)$$

$$GHPF(S) = \frac{S}{S + \dfrac{Gm4}{C3}} \cdot 3 \cdot R \cdot Gm6 \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (2)$$

$$GBPF = \frac{\dfrac{R}{R11} \cdot S \cdot \dfrac{Gm2}{C1} \cdot \dfrac{R11}{R}}{S^2 + S \cdot \dfrac{Gm2}{C1} \cdot \dfrac{R11}{R} + \dfrac{Gm2 \cdot Gm3}{C1 \cdot C2}} \cdot \frac{S}{S + \dfrac{Gm4}{C3}} \cdot 3 \cdot R \cdot Gm1 \dots (3)$$

From (1), (2) and (3), transfer function GEQ(S) of the recording equalizer circuit becomes:

$$GEQ(S) = GLPF(S) + GHPF(S) + GBOF(S) \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (4)$$

From (4):

$$GEQ(S) = \frac{S^3 \cdot e + S^2 \cdot f + S \cdot g + h}{S^3 \cdot a + S^2 \cdot B + S \cdot c + d}$$

$a = C1 \cdot C2 \cdot C3 \cdot R$

$b = C2 \cdot (C3 \cdot R11 \cdot Gm2 \cdot + G \cdot R \cdot Gm4)$

$c = Gm2 \cdot (C3 \cdot R \cdot Gm3 + C2 \cdot R11 \cdot Gm4)$

$d = R \cdot Gm2 \cdot Gm3 \cdot Gm4$

$e = C1 \cdot C2 \cdot C3 \cdot 3 \cdot R^2 \cdot Gm6$

$f = C2 \cdot (C3 \cdot R11 \cdot Gm2 \cdot Gm6 + C1 \cdot R \cdot Gm4 \cdot Gm6 + C3 \cdot R \cdot Gm1 \cdot Gm2) \cdot 3 \cdot R$

$g = Gm2 \cdot (C3 \cdot R \cdot Gm3 \cdot Gm6 + C2 \cdot R11 \cdot Gm4 \cdot Gm5 + C2 \cdot R \cdot Gm1 \cdot Gm4) \cdot 3 \cdot R$

$h = 3 \cdot R \cdot Gm2 \cdot Gm3 \cdot Gm4 \cdot Gm5$

From GEQ(S) above:

- By changing Gm4, medium band correction frequency fM can be changed.
- By changing Gm5, low band gain GL can be changed.
- By changing Gm6, medium band gain GH can be changed.
- By changing Gm1, peaking gain GP can be changed.
- By changing Gm2, the relation Fo/Q between the peaking frequency and Q can be changed.
- By changing Gm3, the relation Fo·Q between the peaking frequency and Q can be changed.

As explained above, CXA1198AP can set at will the six parameters: low band gain, peaking frequency, Q, peaking gain, medium band euqalizing gain, and medium band equalizing frequency, necessary for the recording equalizer.
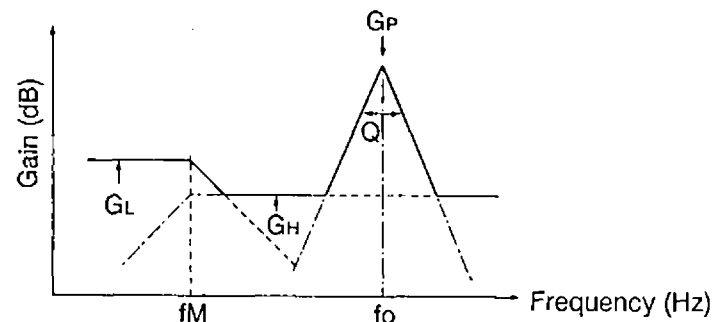

Fig. 4

Configuration of the transconductance amplifier as follows: Fig. 5 shows the basic circuit of the transconductor amplifier.
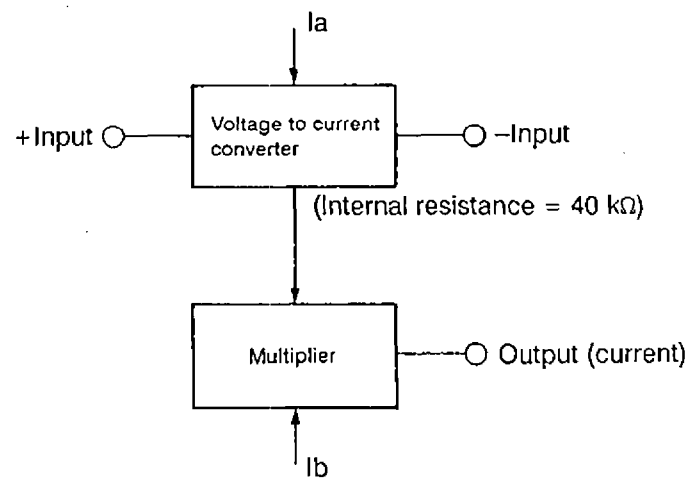

Fig. 5

The variable integrator composed of Gm_2, Gm_3 and Gm_4, uses the referenced voltage generated inside the IC.   Using voltage la provided by the internal diffused resistor and current lb provided by the external resistor, the multiplier changes the voltage into current conversion coefficient.

The ratio of these two currents; la and lb, reflects the irregularity of the diffused resistor.   As the voltage into current converter is formed by of the internal diffused resistor, it is changed by the absolute value and temperature characteristics of the resistance.   However, should the formation comprise la internally and lb externally, the absolute value and temperature characteristics are not any more affected by the diffused resistor.

The variable gain amplifier composed of Gm_1, Gm_5 and Gm_6 uses an internal diffused resistor.   Setting la through an external resistor eliminates dependence on the diffused resistor.

Application Note

1. Power supply
CXA1198AP can be used with either dual supply, or single supply.   Respective connections are shown below.

	Vcc pin 12	VEE pin 5	GND pin 7,10	REF GND pin 4
Dual supply	Vcc	VEE	GND	GND *1
Single supply	Vcc	GND	—*2	GND *1

Note) *1. Connect to the position where each parameter setting resistor is connected.   Do the same with the resistor to be connected to pin 13 IREF.   (See Mode control 3.)
*2. Connect the decoupling capacitor (100 μF or more) to pins 7 and 10 GND during single supply.
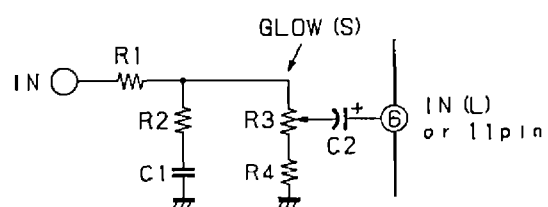
2. Low band equalizing

Fig. 6

As shown in Fig. 6, connecting the time constant circuit of CR to input pins 6 and 11 makes low band correction possible. Transfer function GLOW(S) in Fig. 6 goes:

$$\text{GLOW(S)} = \frac{(R_1 + R_4) \cdot (S \cdot C_1 \cdot R_2 + 1)}{S \cdot C_1 \{R_1 \cdot R_2 + R_1 \cdot (R_3 + R_4) + R_2 \cdot (R_3 + R_4)\} + \{R_1 + (R_3 + R_4)\}}$$

Where: C2 is large enough as the DC cutting capacitor, while the synthetic impedance is sufficiently smaller than the IC input impedance.
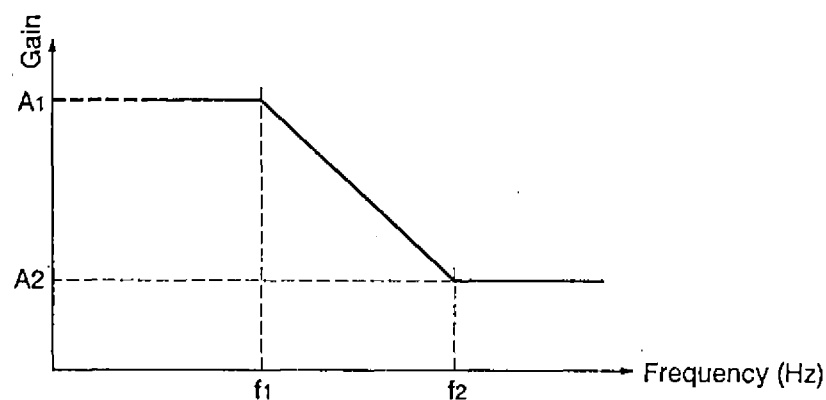

Fig. 7

Accordingly: f1, f2, A1 and A2 in Fig. 7 submit to the following.

$$f_1 = \frac{R_1 + (R_3 + R_4)}{2\pi \cdot C_1 \{R_1 \cdot R_2 + R_1 \cdot (R_3 + R_4) + R_2 \cdot (R_3 + R_4)\}}$$

$$f_2 = \frac{1}{2\pi \cdot C_1 \cdot R_2}$$

$$A_1 = \frac{R_3 + R_4}{R_1 + (R_3 + R_4)}$$

$$A_2 = \frac{R_2 \cdot (R_3 + R_4)}{R_1 \cdot R_2 + R_1 \cdot (R_3 + R_4) + R_2 \cdot (R_3 + R_4)}$$

3. Mode control

For mode control with manual switch, see the application circuit diagram (for Dual and single supply).

When the set is fitted with an auto tape selector and tape mode is logically run, use the same GND for both the common pin of the analog switch IC (Analog switch connection point) and the 24 kΩ resistor that is connected to pins 4 (REF GND) and 13 (IREF) of CXA1198AP.
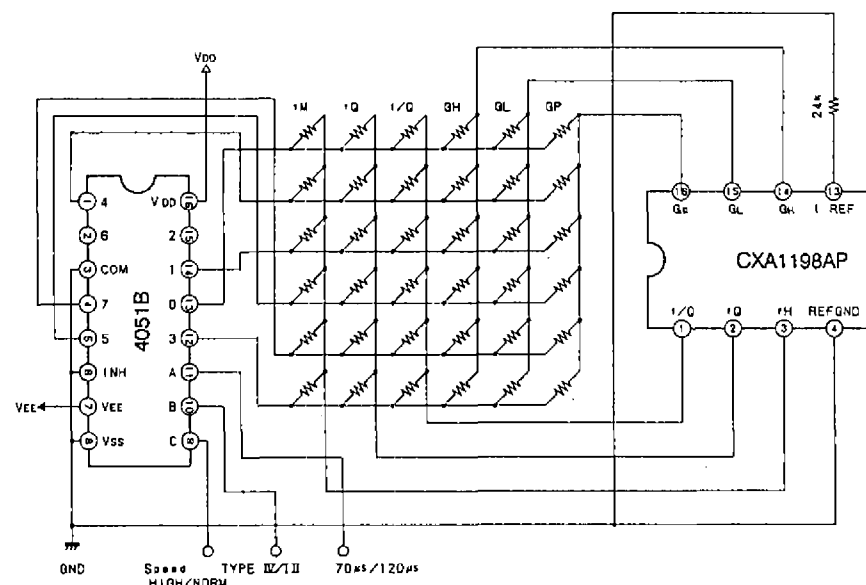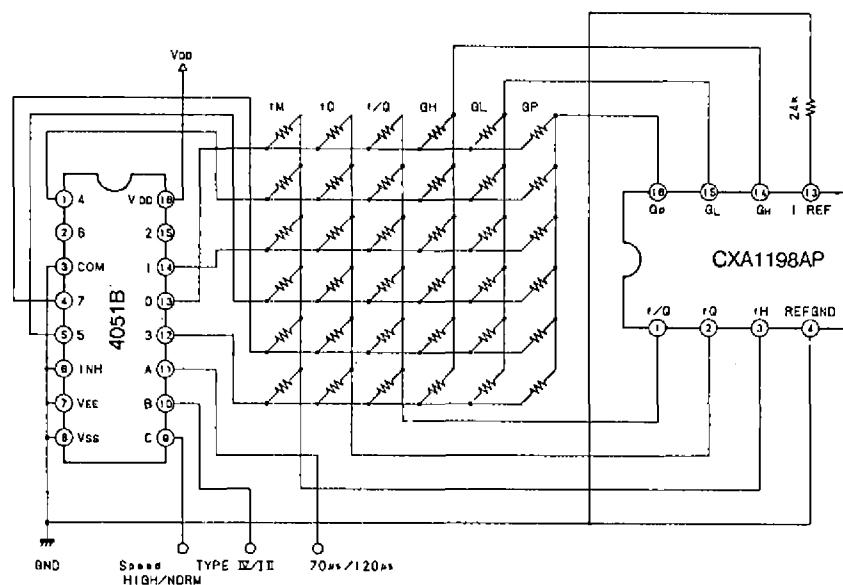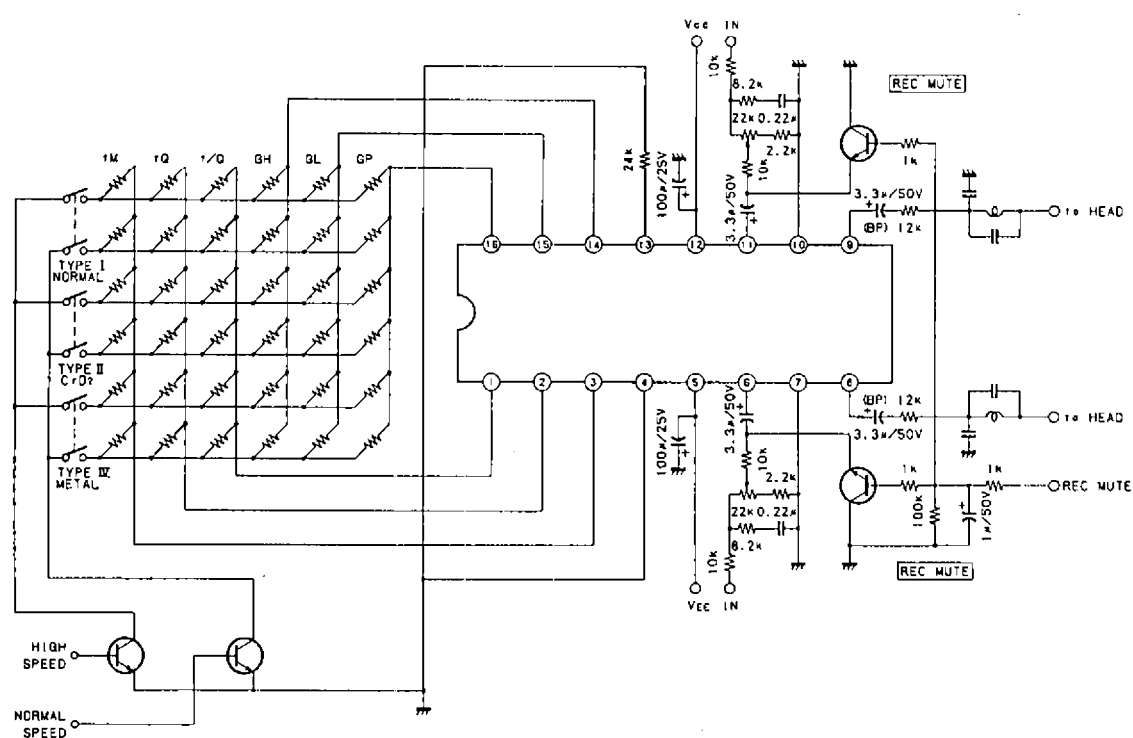

Fig. 8 (a)   Dual supplies

Fig. 8 (b)   Single supply

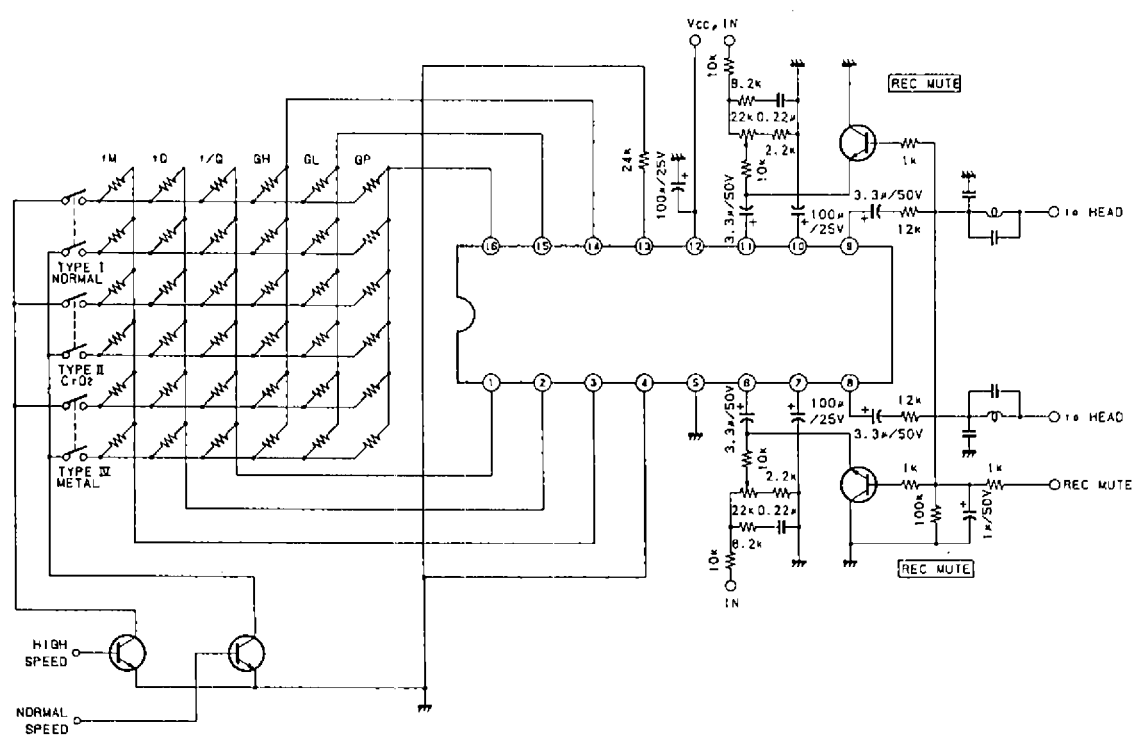## 4. Temperature characteristics and accuracy

Temperature characteristics of CXA1198AP can be vastly improved by using resistors RGL, RGH, RGP, RfM, Rf/Q and RfQ that serve to set the respective parameters and resistors that have a temperature coefficient equivalent to that of the 24 kΩ connected to pin 13 (IREF).

Also, enhancing the accuracy of 24 kΩ (IREF) and resistors that set the various parameters will improve the setting accuracy of those parameters.
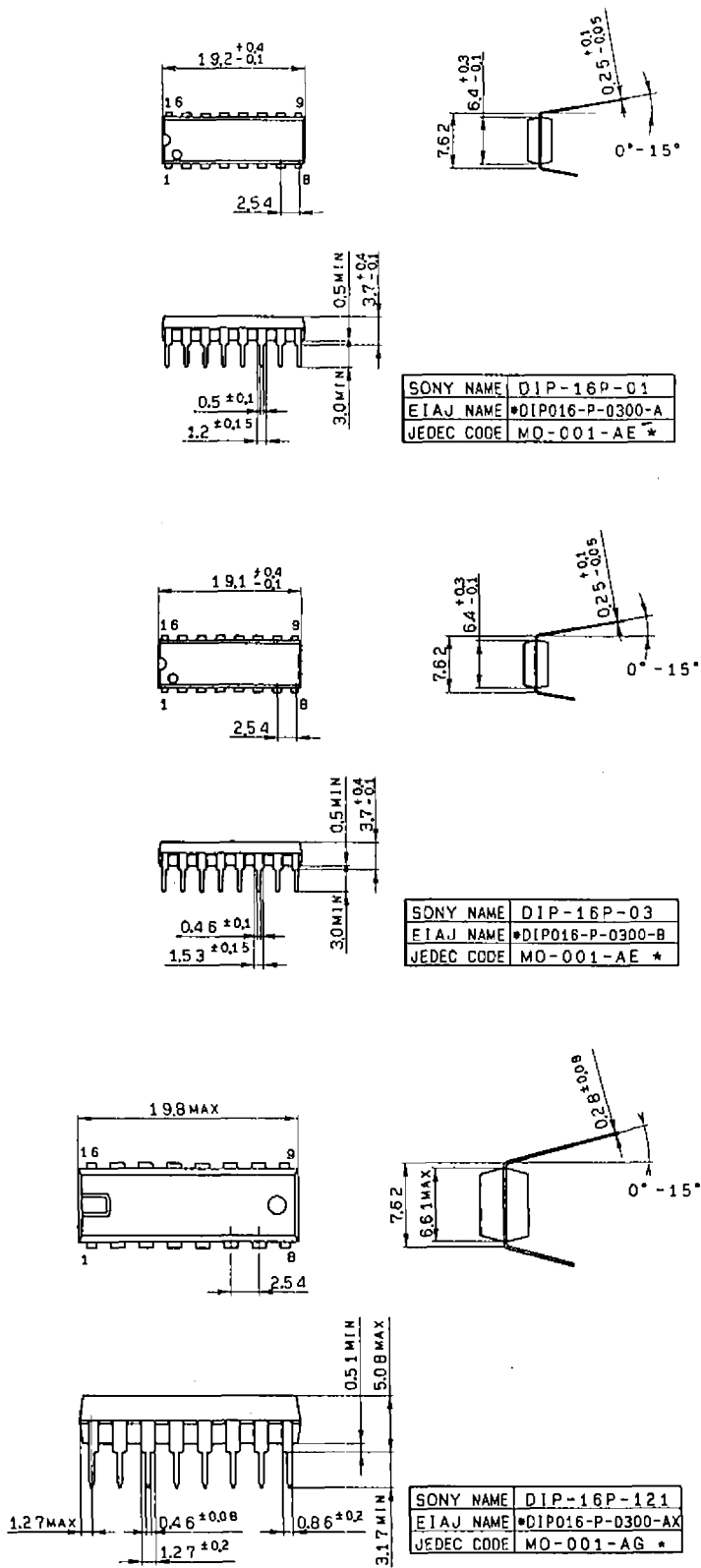
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Application Circuit (Dual supply)

Application Circuit (Single supply)

Package Outline Unit:mm

16pin DIP (Plastic) 300mil 1.0g

SONY NAME	DIP-16P-01
EIAJ NAME	*DIP016-P-0300-A
JEDEC CODE	MO-001-AE *

SONY NAME	DIP-16P-03
EIAJ NAME	*DIP016-P-0300-B
JEDEC CODE	MO-001-AE *

SONY NAME	DIP-16P-121
EIAJ NAME	*DIP016-P-0300-AX
JEDEC CODE	MO-001-AG *

(*Similar)

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