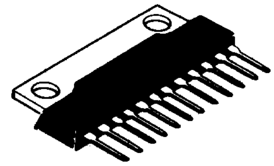
HA1392

Dual 4 to 7W Audio Power Amplifers

The Hitachi audio power IC HA1392 is specifically designed for cassette-radio, encapsulated in 12-lead single-in-line plastic package.
The HA1392 delivers 4.3 watts per channel under 12 volt power supply and 6.8 watts under 15 volt power supply to 4 ohm load.

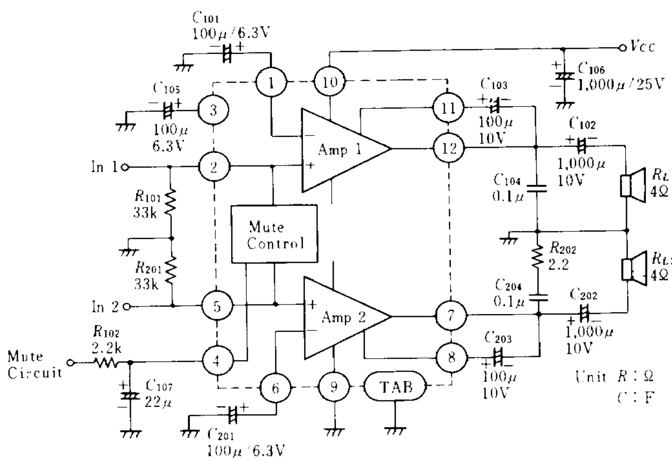


(SP-12T)

■ FEATURES

- A low quiescent current (36mA typ) for efficient battery-operation.
- Designed for low crossover distortion under a low idling current.
- Audio muting circuit included, providing 60dB typ of muting attenuation just by 5mA of muting control current.
- No electrical isolation needed for simple chassis-mounting.
- Dual power amplifiers provide 4.3W typ under 12V power supply voltage and 6.8W typ under 15V power supply voltage. (R_L=4 ohms, THD = 10%)
- Internal thermal protection.

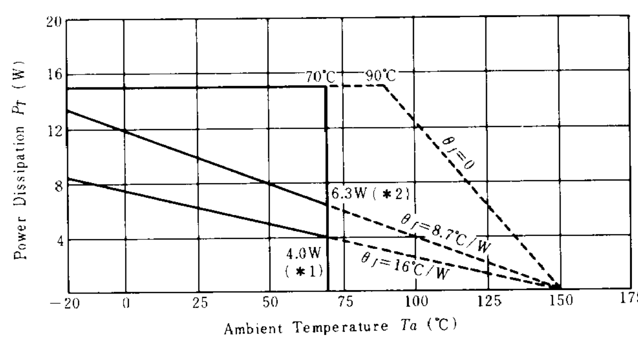
■RECOMMENDED APPLICATION



■ABSOLUTE MAXIMUM RATINGS (Ta=25℃)

Item	Symbol	Rating	Unit
Supply Voltage	V_{CC}	20	V
Output Current	$I_{O(peak)}$	4	A
Power Dissipation	P_T	15(See Note)	W
Junction Temperature	T_j	150	℃
Operating Temperature Range	T_{opr}	−20 to +70	℃
Storage Temperature Range	T_{stg}	−50 to +125	℃

Note: The derating curve is shown below, in which θf is the thermal resistance of heat-sink. θj-c, the thermal resistance between the junction and the case(TAB), is calculated as 4°C/W.



(*1) Max Power Dissipation under V_{CC}=12V, R_L= 4Ω and Dual Operation.
(*2) Max Power Dissipation under V_{CC}=15V, R_L=4Ω and Dual Operation.

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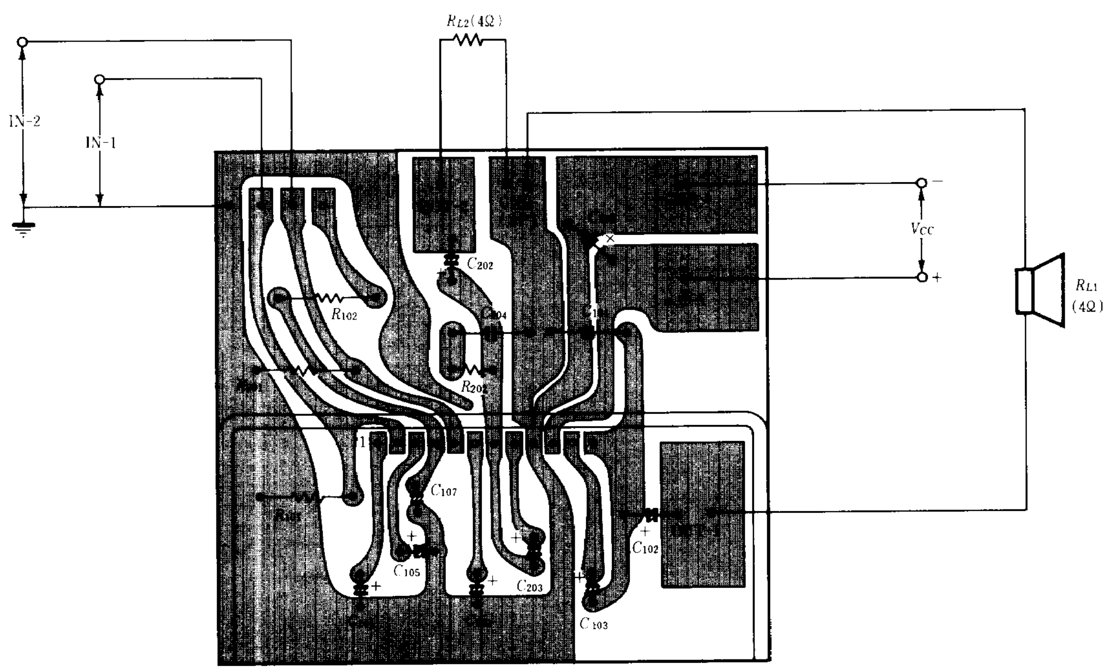
■ELECTRICAL CHARACTERISTICS

(Unless otherwise specified, $Ta=25°C$, $V_{CC}=12V$, $R_L=4\,\Omega$, $f=1kHz$, and $R_g=600\Omega$, under Dual Amp Operation)

Item	Symbol	Test Condition		min	typ	max	unit
Quiescent Current	I_Q	$V_{in}=0V$		—	36	60	mA
Input Bias Current	I_B	$V_{in}=0V$		—	—	1.0	μA
Voltage Gain	G_V	$V_{in}=46dBm$		44	46	48	dB
Difference of Voltage Gain	ΔG_V	$V_{in}=-46dBm$		—	—	±1.5	dB
Output Power per Channel	P_{out}	$THD=10\%$	$V_{CC}=12V$	3.8	4.3	—	W
			$V_{CC}=15V$	6.0	6.8	—	W
Total Harmonic Distortion	THD	$P_{out}=0.5W$		—	0.25	1.0	%
Noise Output	WBN	$R_g=10k\Omega$, $BW=20Hz$ to $20kHz$		—	0.4	1.0	mV
Supply Voltage Rejection Ratio	SVR	$f=100Hz$, $V_{ripple}=0dBm$		40	44	—	dB
Roll-off Frequency	f_H	$V_{in}=-46dBm$, $G_V=-3dB$ ($f=1kHz$ Ref)		12	20	33	kHz
Cross-Talk	CT	$V_{in}=-46dBm$		—	60	—	dB
Muting Attenuation	ATT	$I_{MUTE}=5mA$, $V_{in}=-46dBm$		—	60	—	dB

■PC-BOARD LAYOUT PATTERN

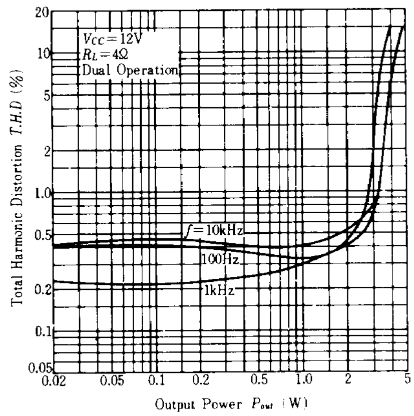


(Top View)

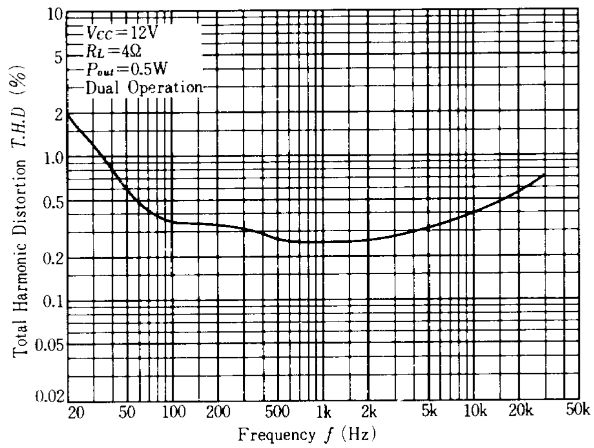
■EXTERNAL COMPONENTS

Parts No.	Recommended Value	Purpose	Larger than recommended value	Smaller than recommended value
C_{101}, C_{201}	100μF	Inverting DC decoupling	—	Higher low frequency roll-off
C_{102}, C_{202}	1000μF	Output coupling to load	Causes burn-out	Higher low frequency roll off
C_{103}, C_{203}	100μF	Boot strap	Causes burn-out	Smaller power bandwidth
C_{104}, C_{204}	0.1μF	Frequency stability	Increases current consumption at high frequency	Causes oscillation
C_{105}	100μF	Ripple rejection	—	Pop sound at switch-on
C_{106}	1000μF	Supply bypassing	—	Causes oscillation
C_{107}	22μF	Pop sound at mute on/off	—	—
R_{101}, R_{201}	33kΩ	Input resistance	—	—
R_{202}	2.2Ω	Frequency stability	Causes of oscillation	Causes oscillation
R_{102}	2.2kΩ	Pop sound at mute on/off	—	—

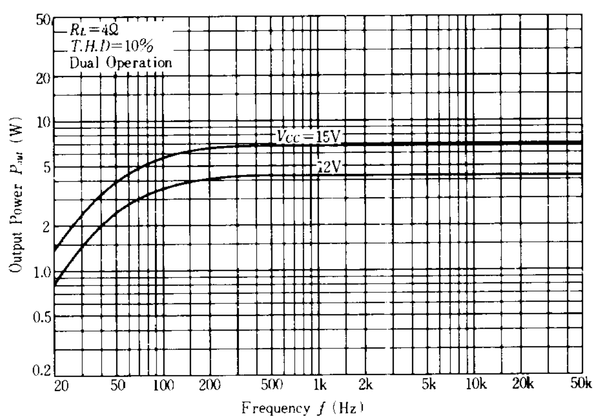
TOTAL HARMONIC DISTORTION VS. OUTPUT POWER



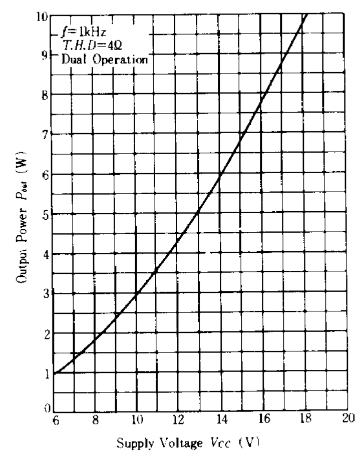
TOTAL HARMONIC DISTORTION VS. FREQUENCY



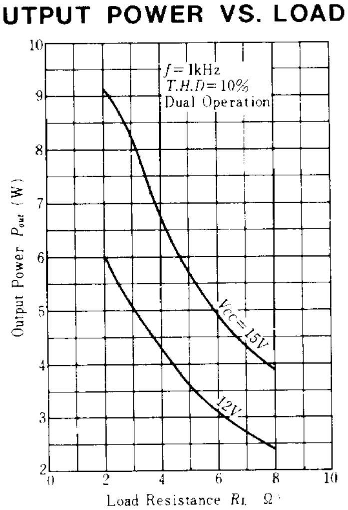
OUTPUT POWER VS. FREQUENCY



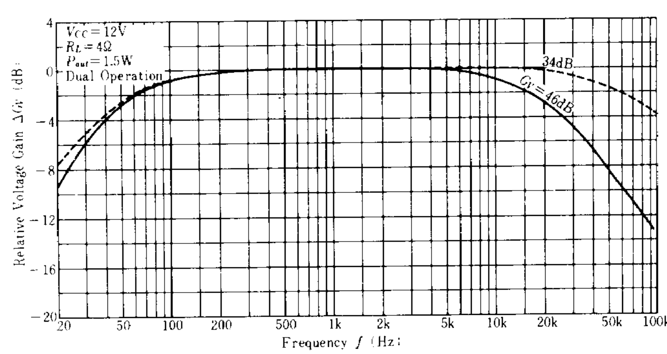
OUTPUT POWER VS. SUPPLY VOLTAGE



OUTPUT POWER VS. LOAD RESISTANCE



RELATIVE VOLTAGE GAIN VS. FREQUENCY



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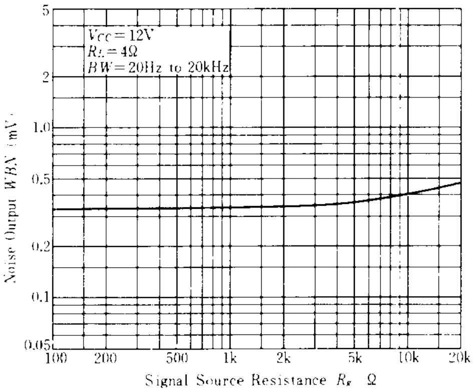
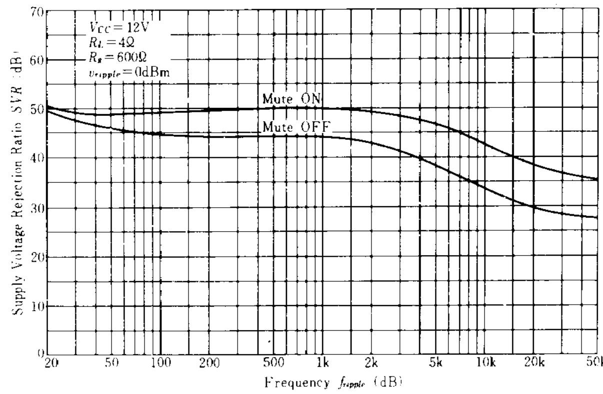
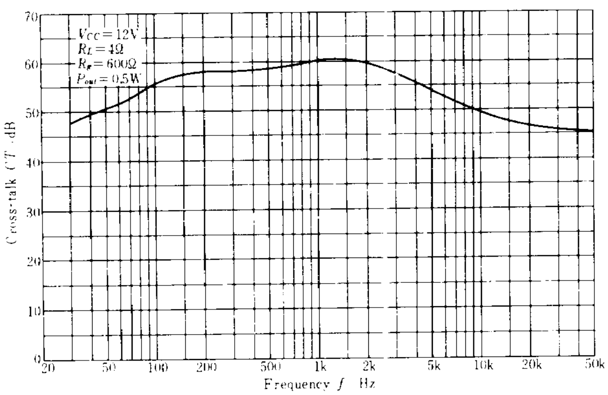
NOISE OUTPUT VS. SIGNAL SOURCE RESISTANCE



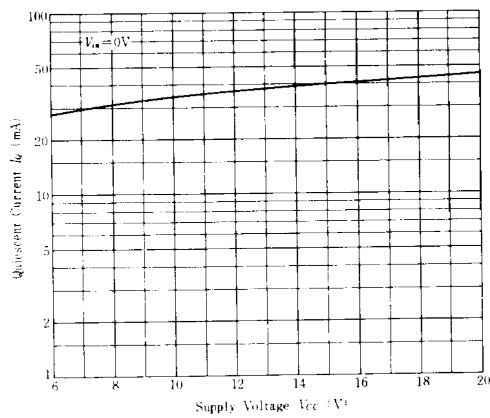
SUPPLY VOLTAGE REJECTION RATIO VS. FREQUENCY



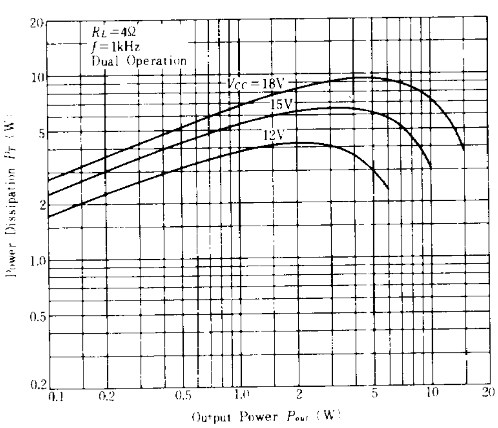
CROSS-TALK VS. FREQUENCY



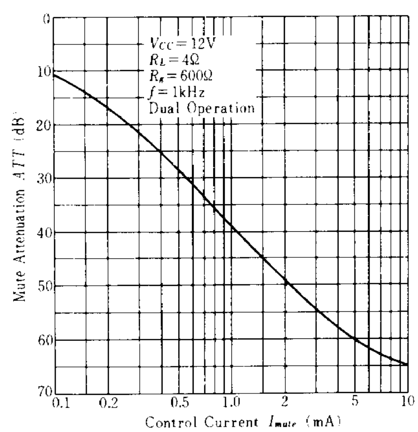
QUIESCENT CURRENT VS. SUPPLY VOLTAGE



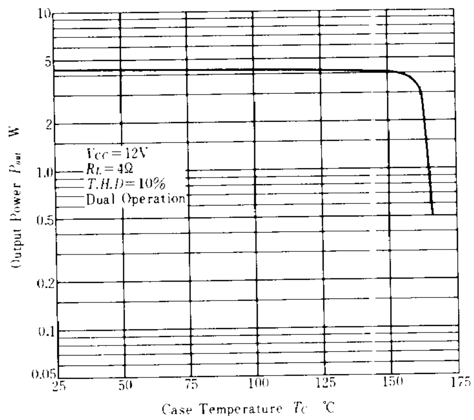
POWER DISSIPATION VS. OUTPUT POWER



MUTE ATTENUATION VS. CONTROL CURRENT



OUTPUT POWER VS. CASE TEMPERATURE



■ AUDIO-MUTING CIRCUIT

The built-in audio-muting circuit provides the following functions:

1. Prevents howling under REC Mode with built-in microphones.
2. Controls output signal under CUE and REVIEW Modes.
3. Prevents shock-noise caused by function-switching.
4. Absorbs shock-noise generated by Pre- or Line-Amp at power-ON.
5. Muting under AM/FM detuning.

● FEATURES

1. Large attenuation under a low control current: 60dB typ of mute attenuation (ATT) under 5mA of control current (I_{MUTE}) and 600 ohms of signal source resistance (Rg).
2. Very low shock-noise against mute-switching.
3. Adjustable mute attenuation by controlling muting-control current.

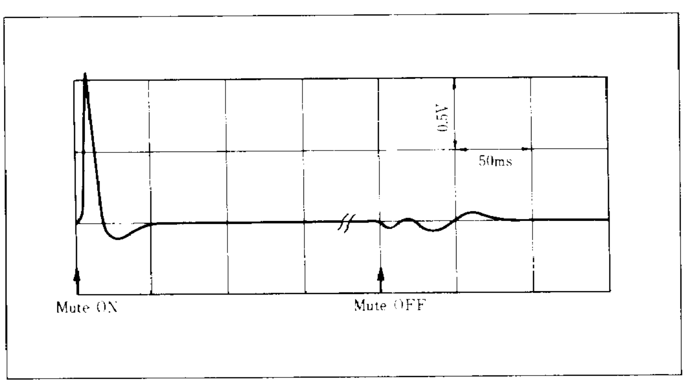


Fig. 1 Shock Noise by Mute-Switching

● OPERATION PRINCIPLE

Muting circuit functions by supplying current to pin-4 (Mute Terminal).

A capacitor of 10μF, connected between pin-4 and GND, prevents shock-noise caused by mute-switching or by muting circuit malfunction due to the external disturbances.

Mute set-up time t_1 and the recovery time t_2 will be decided by the time constant at pin-4. Shorter t_2 will be obtained by connecting a resistor to C_{107} in parallel.

Fig. 3 shows an example of the muting-circuit at the REC Mode with built-in microphones.

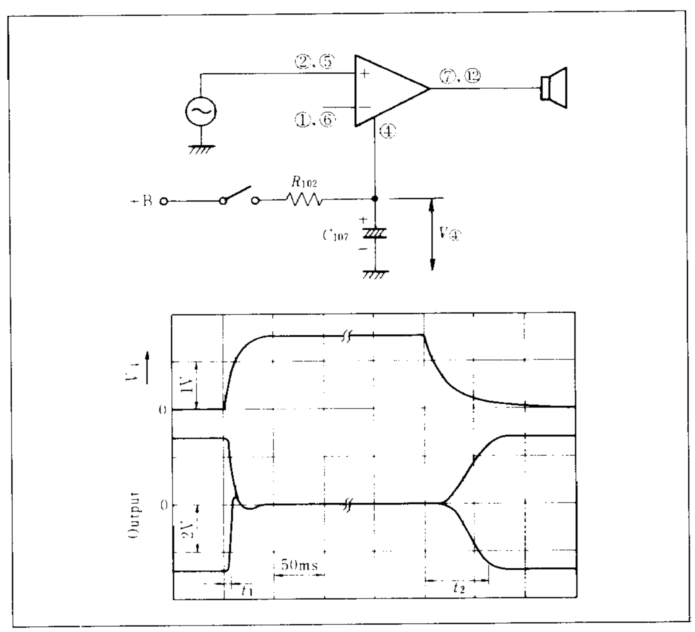


Fig. 2 Muting Operation

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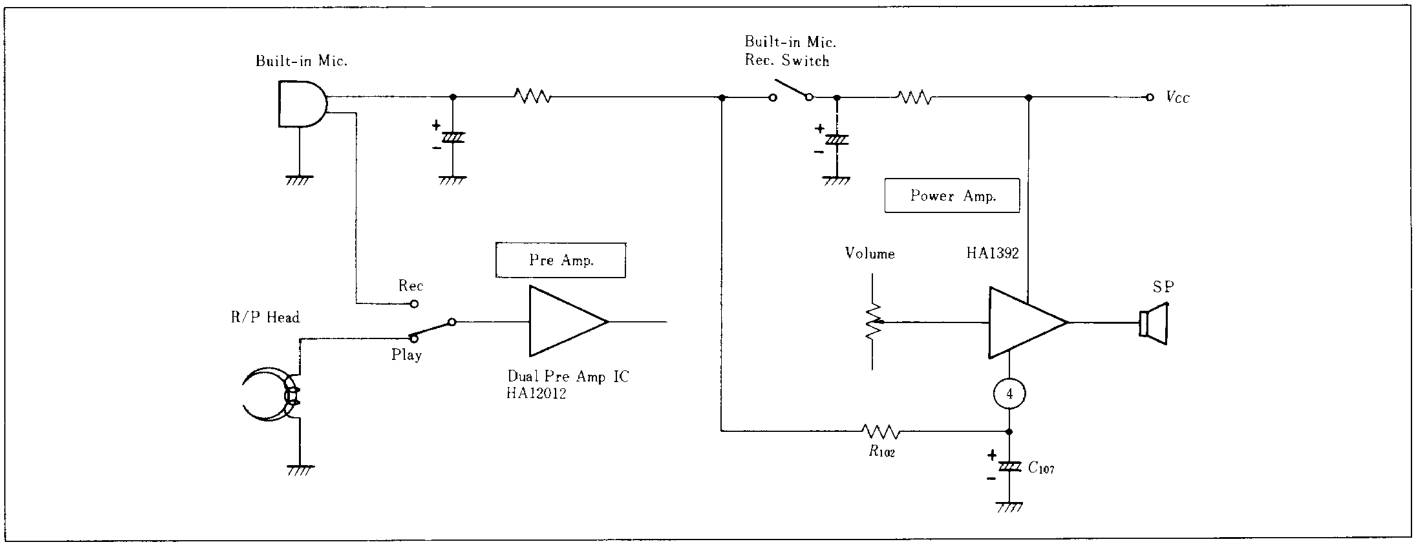

Fig. 3 The System Muting-Circuit under REC Mode with Built-in Mic.

■ VOLTAGE GAIN

The Ha1392 is designed to have 45dB typ of voltage gain (decided by internal resistance ratio).

To reduce residual hum and noise, the voltage gain may be reduced by connecting additional resistors externally.

The following two methods are recommended for the purpose.

Method 1: Connecting Two External Resistors

As shown in Fig. 4, resistors R_{103} and R_{203} are connected in series to capacitors C_{101} and C_{201} (100μF) at pins 1 and 6.

The voltage gain is decided by the equation

$$Gv = \frac{20000\ (\Omega)}{100\ (\Omega) + R_{103}\ \ (\Omega)}$$

where Gv is voltage gain, and 20000 (Ω) and 100 (Ω) are the values of internal feedback resistors.

40dB of voltage gain, for example, is obtained by connecting 100 ohms of R_{103} and 100 ohms of R_{203}.

This method may cause ±3dB max of Gv variation resulting from the variation of internal resistance.

Method 2: Connecting Four External Resistors

As shown in Fig. 5, two more resistors R_{104} and R_{204} are connected. R_{103} must be smaller than or equal to 10 ohms.

The voltage gain is decided by the equation

$$Gv = \frac{1}{\frac{1}{200} + \frac{R_{103}}{R_{104}}}$$

where $\frac{1}{200}$ is the internal feedback-resistance ratio.

This method, not affected by the variation of internal resistance, will result in small Gv variation of approx. ±1dB.

If the R_{104} is connected to the Output Terminal (pin-12), the quiescent current will be increased due to the DC current

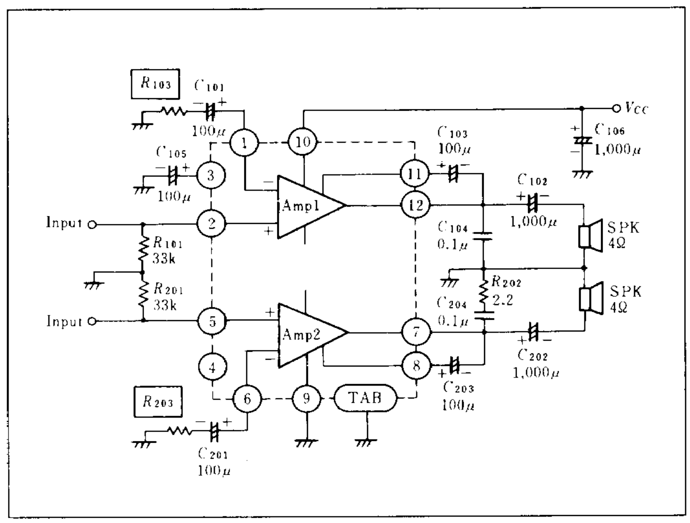

Fig. 4 EXAMPLE CIRCUIT FOR METHOD 1

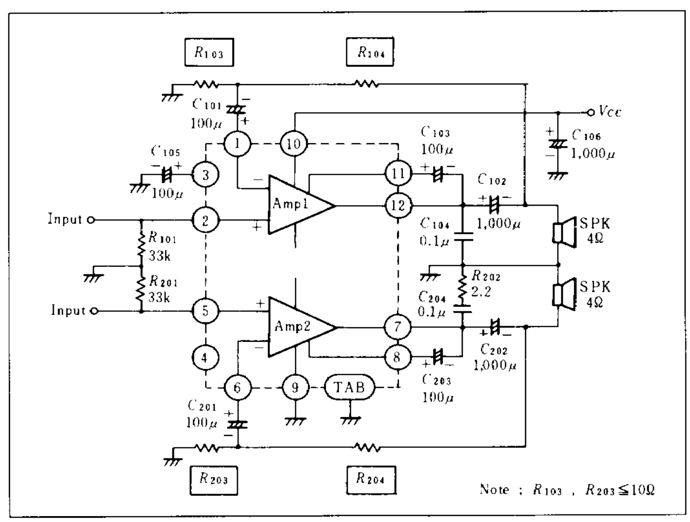

Fig. 5 EXAMPLE CIRCUIT FOR METHOD 2

through the R_{104}.

Cautions

(a) Gv must be larger than or equal to 34dB.
(b) Larger Gv than 46dB typ cannot be achieved. (Limited by the internal resistor ratio).

■ CAUTIONS FOR PC-BOARD PATTERN DESIGNING

The following precautions should be taken into account for the PC-board layout of this IC, since it has only one ground-pin (pin-9).

(1) GROUND PATTERNS

As shown in Fig. 6, devide the Ground (GND) circuit into three lines around pin-9, like the input side GND, the output side GND and the power supply side GND. Connect the external parts according to the table.

External Parts No.	Connected to
C_{101}, C_{105}, C_{107}, C_{201}, R_{101}, R_{201}	Input Side GND
C_{104}, R_{202}, Speaker	Output Side GND
C_{106}	Power Supply Side GND

The IC TAB must be connected to the power supply side GND.
Several milli-ohms of on-PCB common impedance on the input- and the output-side GNDs, will deteriorate the IC characteristics — interchannel cross-talk, total harmonic distortion, and ripple rejection under muting.

(2) C_{106} (100μF)

C_{106}, connected between power supply and GND, should be placed within 30mm of the IC.
If sufficient space for a 1000μF capacitor is not permitted, another capacitor of approx. 100μF must be connected within 30mm of the IC. Without any capacitors near the IC, AM-band reception will be deteriorated.

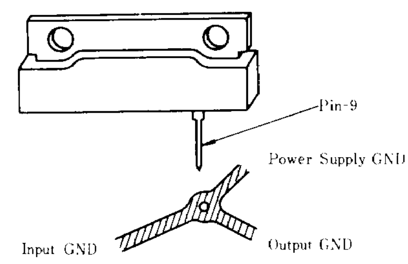

Fig. 6 Ground Circuit

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