

# HA1392

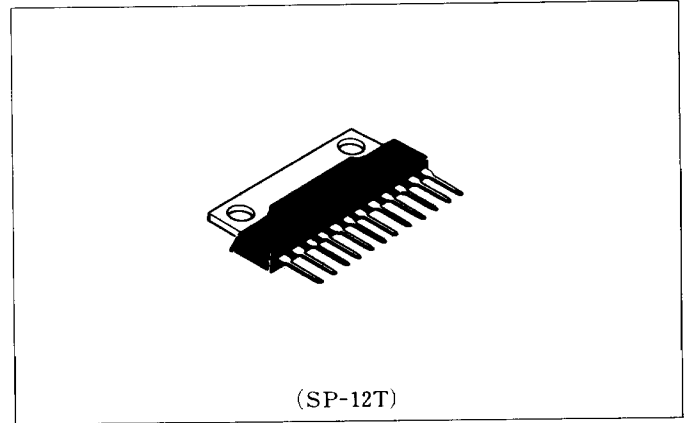
## Dual 4 to 7W Audio Power Amplifiers

The Hitachi audio power IC HA1392 is specifically designed for cassette-radio, encapsulated in 12-lead single-in-line plastic package.

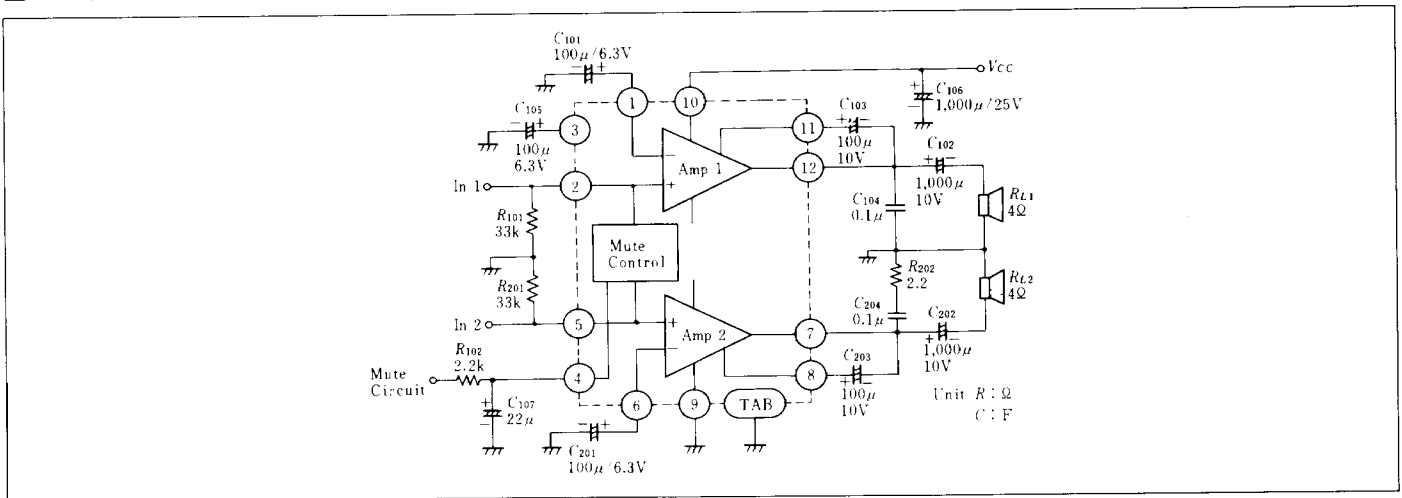
The HA1392 delivers 4.3 watts per channel under 12 volt power supply and 6.8 watts under 15 volt power supply to 4 ohm load.

### 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.



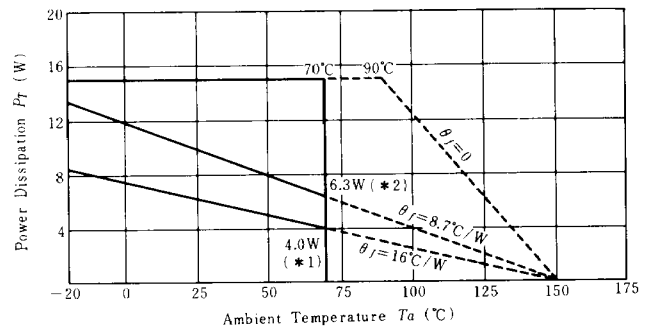
### RECOMMENDED APPLICATION



### ABSOLUTE MAXIMUM RATINGS ( $T_a=25^\circ\text{C}$ )

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

Note: The derating curve is shown below, in which  $\theta_f$  is the thermal resistance of heat-sink.  $\theta_{j-c}$ , the thermal resistance between the junction and the case(TAB), is calculated as  $4^\circ\text{C}/\text{W}$ .



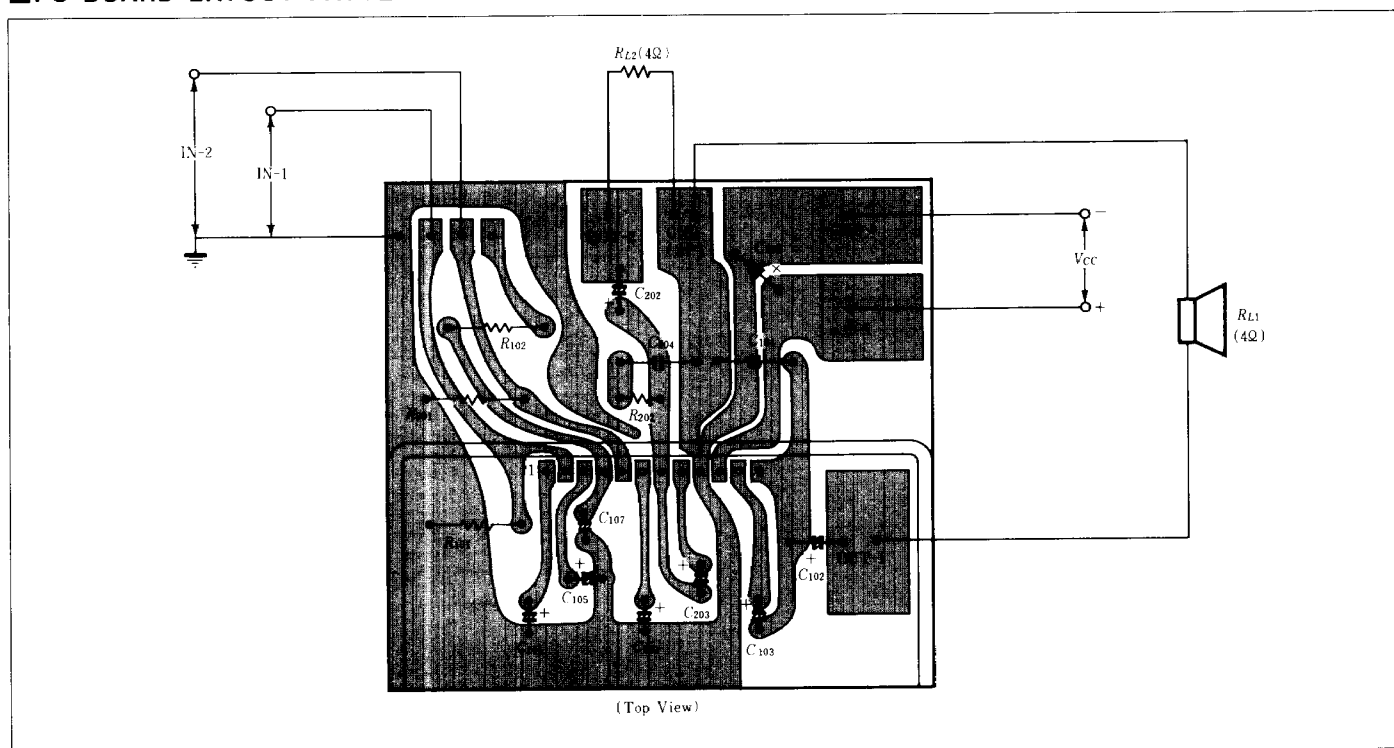
- (\*1) Max Power Dissipation under  $V_{CC}=12\text{V}$ ,  $R_L=4\Omega$  and Dual Operation.
- (\*2) Max Power Dissipation under  $V_{CC}=15\text{V}$ ,  $R_L=4\Omega$  and Dual Operation.

**ELECTRICAL CHARACTERISTICS**

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

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

**PC-BOARD LAYOUT PATTERN**

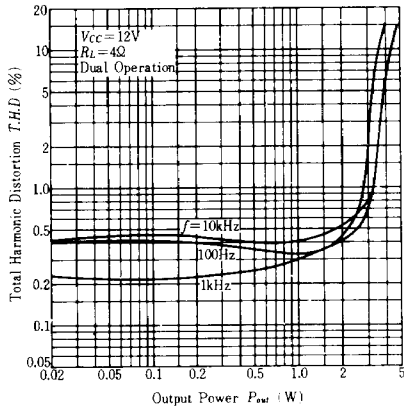


**EXTERNAL COMPONENTS**

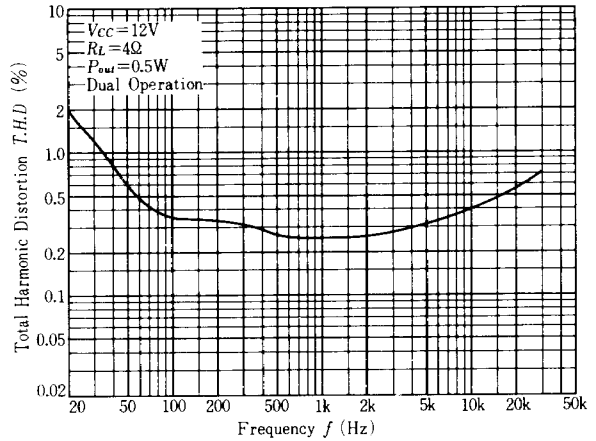
Parts No.	Recommended Value	Purpose	Larger than recommended value	Smaller than recommended value
$C_{101}, C_{201}$	100 $\mu\text{F}$	Inverting DC decoupling	—	Higher low frequency roll-off
$C_{102}, C_{202}$	1000 $\mu\text{F}$	Output coupling to load	Causes burn-out	Higher low frequency roll off
$C_{103},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



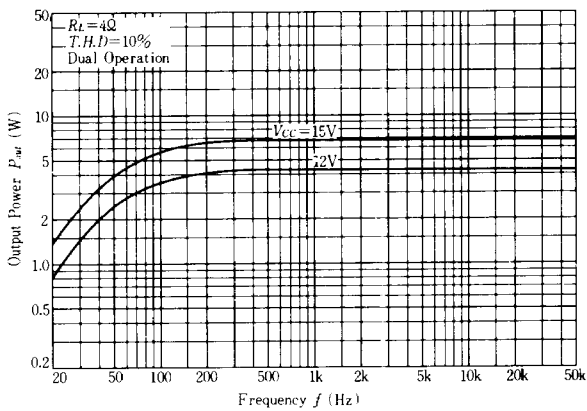
**TOTAL HARMONIC DISTORTION VS. OUTPUT POWER**



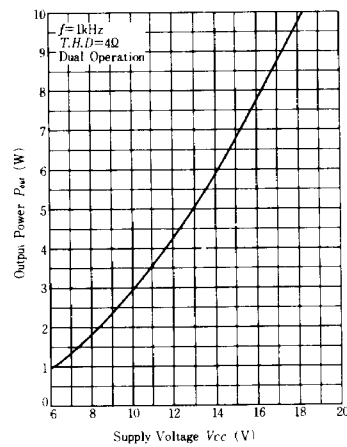
**TOTAL HARMONIC DISTORTION VS. FREQUENCY**



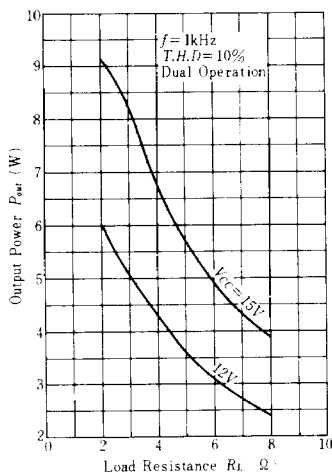
**OUTPUT POWER VS. FREQUENCY**



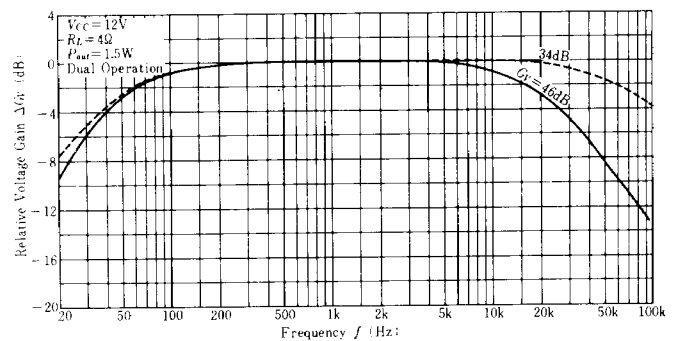
**OUTPUT POWER VS. SUPPLY VOLTAGE**



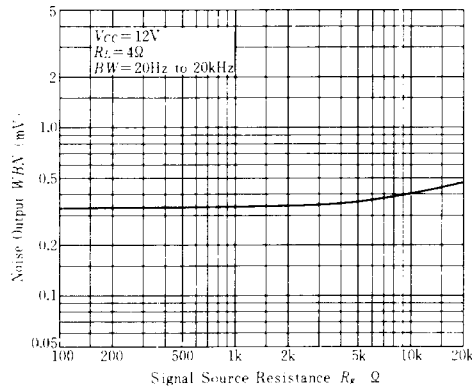
**OUTPUT POWER VS. LOAD RESISTANCE**



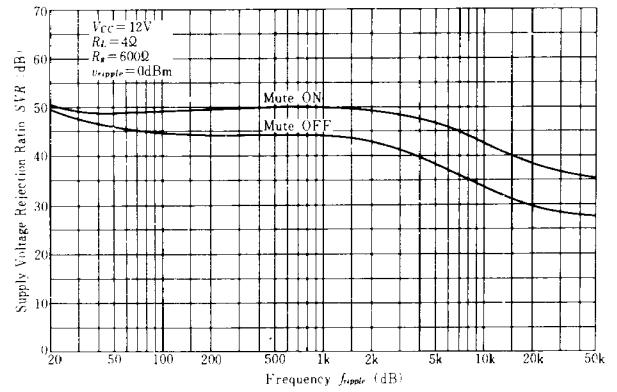
**RELATIVE VOLTAGE GAIN VS. FREQUENCY**



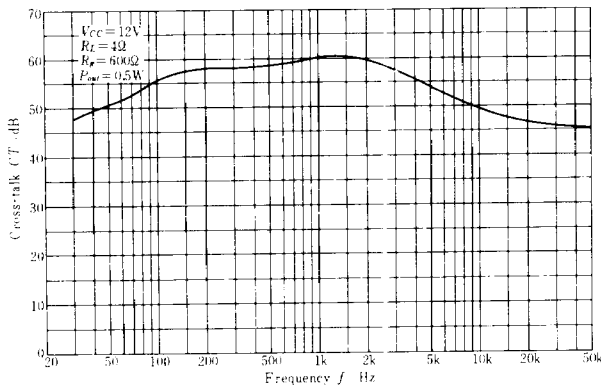
**NOISE OUTPUT VS. SIGNAL SOURCE RESISTANCE**



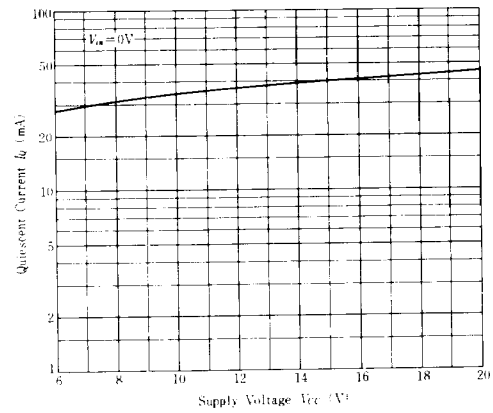
**SUPPLY VOLTAGE REJECTION RATIO VS. FREQUENCY**



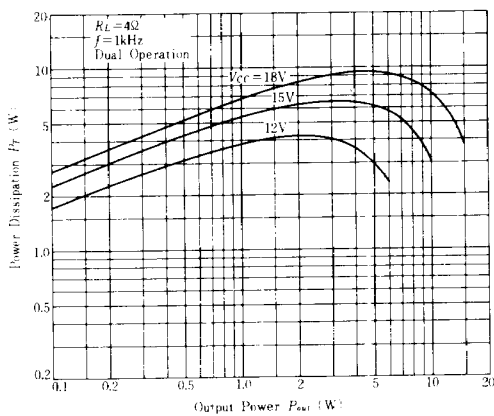
**CROSS-TALK VS. FREQUENCY**



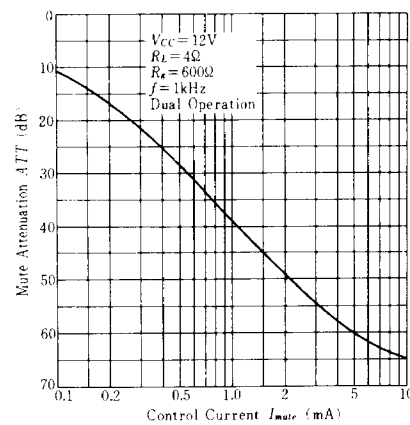
**QUIESCENT CURRENT VS. SUPPLY VOLTAGE**



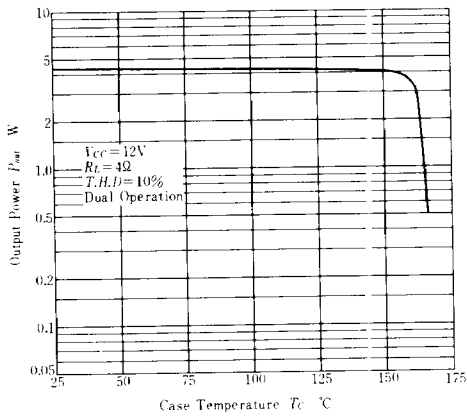
**POWER DISSIPATION VS. OUTPUT POWER**



**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 ( $R_g$ ).
2. Very low shock-noise against mute-switching.
3. Adjustable mute attenuation by controlling muting-control current.

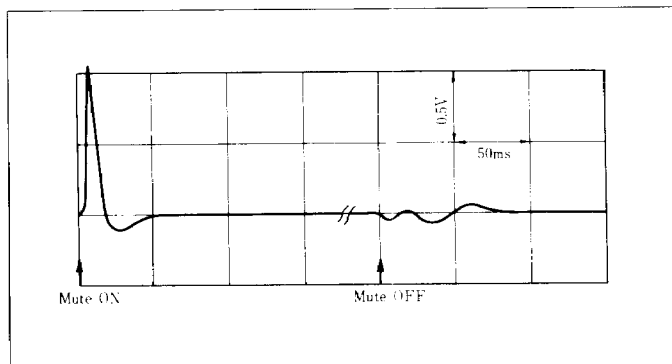


Fig. 1 Shock Noise by Mute-Switching

● OPERATION PRINCIPLE

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

A capacitor of  $10\mu F$ , 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.

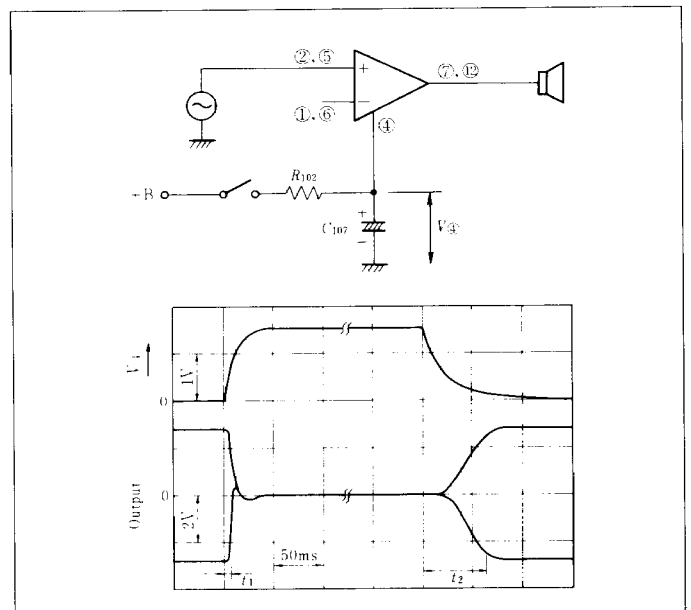


Fig. 2 Muting Operation

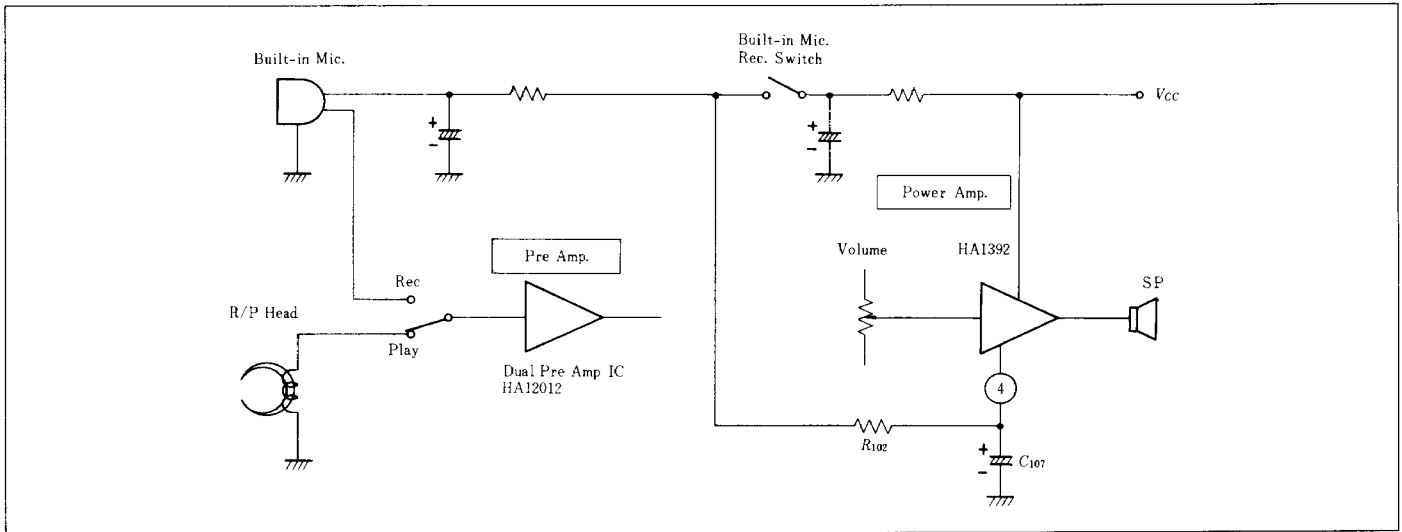


Fig. 3 The System Muting-Circuit under REC Mode with Built-in Mic.

■ 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<sub>103</sub> and R<sub>203</sub> are connected in series to capacitors C<sub>101</sub> and C<sub>201</sub> (100μF) at pins 1 and 6.

The voltage gain is decided by the equation

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

where G<sub>v</sub> 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<sub>103</sub> and 100 ohms of R<sub>203</sub>.

This method may cause ±3dB max of G<sub>v</sub> variation resulting from the variation of internal resistance.

Method 2: Connecting Four External Resistors

As shown in Fig. 5, two more resistors R<sub>104</sub> and R<sub>204</sub> are connected. R<sub>103</sub> must be smaller than or equal to 10 ohms.

The voltage gain is decided by the equation

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

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

This method, not affected by the variation of internal resistance, will result in small G<sub>v</sub> variation of approx. ±1dB.

If the R<sub>104</sub> is connected to the Output Terminal (pin-12), the quiescent current will be increased due to the DC current

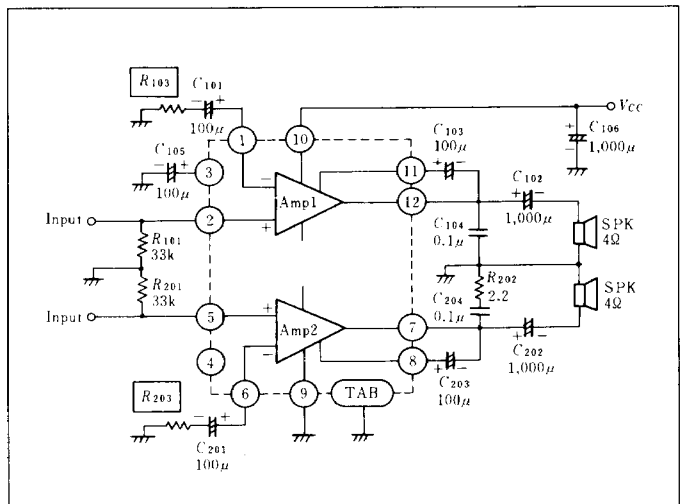


Fig. 4 EXAMPLE CIRCUIT FOR METHOD 1

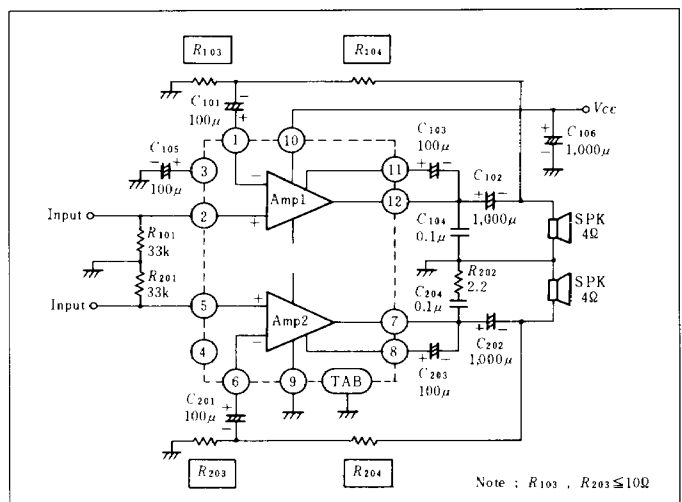


Fig. 5 EXAMPLE CIRCUIT FOR METHOD 2

through the  $R_{104}$ .

**Cautions**

- (a)  $G_v$  must be larger than or equal to 34dB.
- (b) Larger  $G_v$  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, divide 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
$C_{104}, R_{202}, \text{Speaker}$	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)  $C_{106}$  (100 $\mu$ F)**

$C_{106}$ , connected between power supply and GND, should be placed within 30mm of the IC.

If sufficient space for a 1000 $\mu$ F capacitor is not permitted, another capacitor of approx. 100 $\mu$ F must be connected within 30mm of the IC. Without any capacitors near the IC, AM-band reception will be deteriorated.

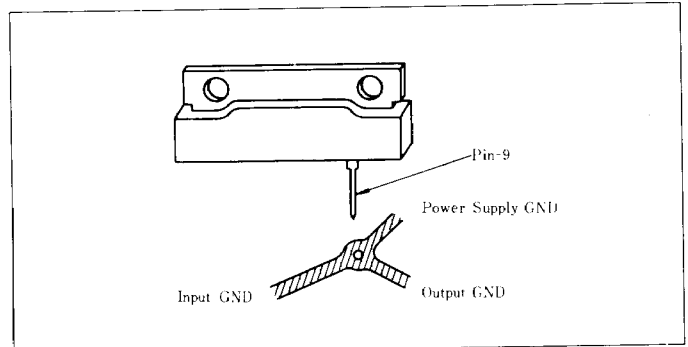


Fig. 6 Ground Circuit