Monolithic Linear IC

No.1718B

SANYO

LA4550

2-Channel AF Power Amp for Radio, Tape Recorder Use

Features

- Low quiescent current
- On-chip 2 channels permitting use in stereo and bridge amplifier applications
- High output
- Mimimum number of external parts required (9 pcs. minimum)
- Good ripple rejection (at steady state)
- Soft tone at the output saturation mode
- Good channel separation
- Easy thermal design
- Small pop noise at the time of power supply ON/OFF
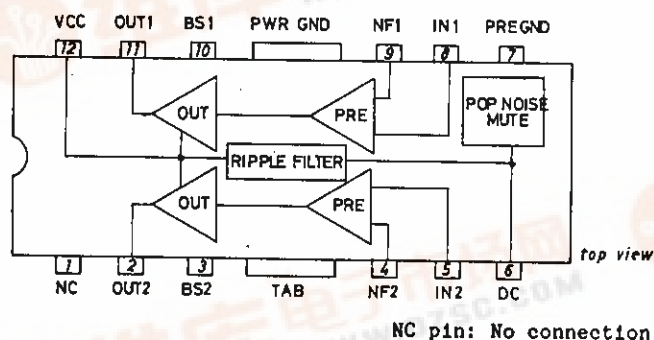
Maximum Ratings at Ta=25°C

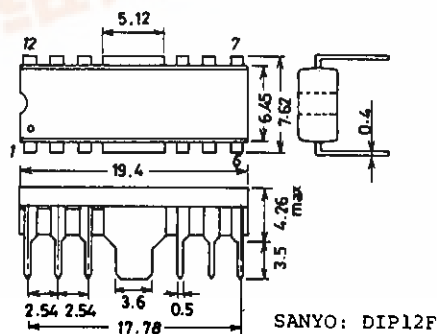|			unit
Maximum Supply Voltage	$V_{CC}max$	13	V
Allowable Power Dissipation	Pdmax*	4	W
Operating Temperature	Topr	-20 to +75	°C
Storage Temperature	Tstg	-55 to +150	°C

* With recommended PCB (See sample printed circuit pattern.)

Operating Conditions at Ta=25°C

				unit
Recommended Supply Voltage	V_{CC}		6,9	V
Recommended Load Resistance	R_L	Stereo 6V	2 to 8	ohm
		BTL 6V	4 to 8	ohm
		Stereo 9V	4 to 8	ohm
		BTL 9V	8	ohm
Operating Voltage Range	$V_{CC}op$		3.6 to 12	V

Equivalent Circuit Block Diagram

top view

NC pin: No connection

Package Dimensions
(unit: mm)
3022A

SANYO: DIP12F

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Operating Characteristics at $Ta=25^{\circ}C, V_{CC}=9V, f=1kHz, Rg=600ohms, R_L=4ohms,$
( ): $R_L=8ohms$, See specified Test Circuit.

|			min	typ	max	unit
Quiescent Current	Icco	Stereo 9V		15	30	mA
		6V		13		mA
Voltage Gain	VG	Rf=0, V_{IN}=-51dBm	49	51	53	dB
Voltage Gain Difference	ΔVG	Rf=0, V_{IN}=-51dBm			$\pm$1	dB
Ouput Power	Po	Stereo: Vcc=6V, THD=10%	0.6	1.0		W
		BTL: Vcc=6V, THD=10%		2.5		W
		Stereo: Vcc=9V, THD=10%	1.6	2.1		W
		BTL: Vcc=9V, THD=10%		(4.1)		W
Total Harmonic Distortion	THD	Po=250mW		0.3	1.5	%
Input Resistance	ri		21	30		kohm
Ouput Noise Voltage	V_{NO}	Rg=0		0.5	1.0	mV
		Rg=10kohms		0.8	2.0	mV
Ripple Rejection	Rr	Rg=0, f=100Hz, V_R=150mV	40	48		dB
Crosstalk	CT	Rg=10kohms, f=1kHz, Vo=0dBm	40	58		dB

Pd max - Ta

Fin 1   Fin 2
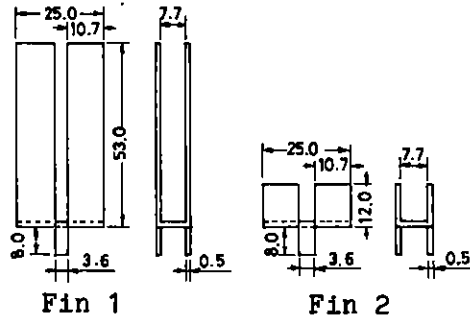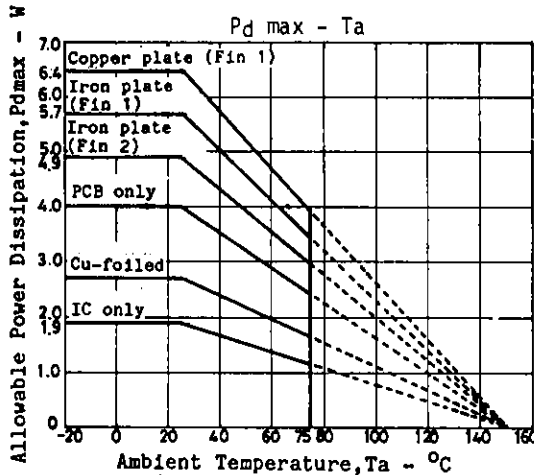
Sample Application Circuit
[Stero Use]
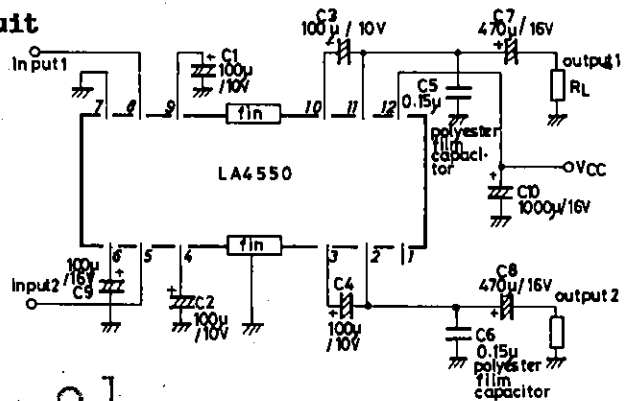
LA4550

Sample Printed Circuit Pattern
Cu foil-reduced board
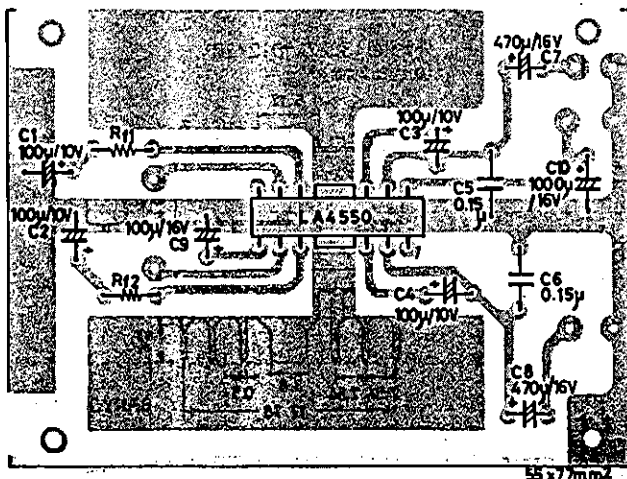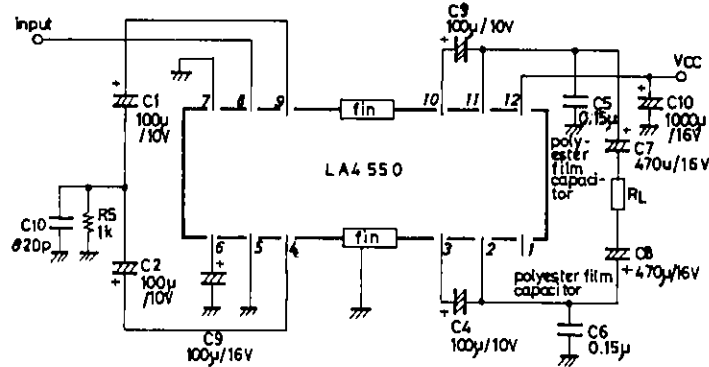
Unit (resistance: Ω, capacitance: F)

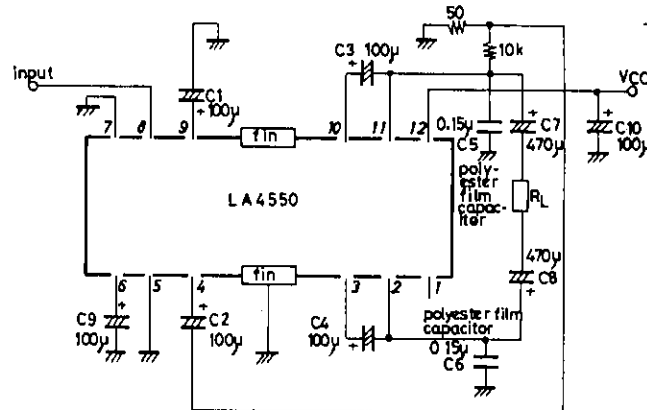Sample Printed Circuit Pattern
(Cu-foiled area) for Stereo Use

[BTL Use 1]

(circuit diagram: LA4550 BTL Use 1)

Input

C9 100μ/10V

Vcc

C1 100μ/10V
7 8 9
fin 10 11 12
LA4550
C5 0.15μ
polyester film capacitor
C10 1000μ/16V
C7 470u/16V
RL

C10 620p
R5 1k

C2 100μ/10V
6 5 4
fin
3 2 1
C8 +470μ/16V
polyester film capacitor

C9 100μ/16V
C4 100μ/10V
C6 0.15μ

[BTL Use 2]

Unit (resistance: Ω, capacitance: F)

(circuit diagram: LA4550 BTL Use 2)

Input

50
10k
C3 100μ
Vcc

C1 +100μ
7 8 9
fin 10 11 12
C5 0.15μ
polyester film capacitor
C7 470μ
C10 100μ
LA4550
RL

C9 100μ
C2 100μ
6 5 4
fin
3 2 1
C4 100μ
polyester film capacitor
C8 470μ
C6 0.15μ

Description of External Parts

C1(C2): Feedback capacitor. The low cutoff frequency is determined by the following formula.

$$f_L = \frac{1}{2\pi C_1 R_f}$$

Rf: Feedback resistor
fL: Low cutoff frequency

Since this capacitor as well as decoupling capacitor affects the starting time, the capacitor value must be fixed with the necessary low frequency band fully considered.

C3(C4): Bootstrap capacitor. The output at low frequencies depends on this capacitor. Decreasing the capacitor value lowers the output at low frequencies. A capacitor value of 47uF or more is required.

C5(C6): Oscillation blocking capacitor. Use a polyester film capacior that is good in high frequency response and temperature characteristic. The use of an electrolytic capacitor, ceramic capacitor may cause oscillation to occur at low temperatures.

C7(C8): Output capacitor. The low cutoff frequency is determined by the following formula.

$$f_L = \frac{1}{2\pi C_7 R_L}$$

fL: Low cutoff frequency
RL: Load resistance

To make the low frequency response in the bridge amplifier mode identical with that in the stereo mode, the capacitor value must be doubled.

C9: Decoupling capacitor. Used for the ripple filter. Since the rejection effect is saturated the capacitor value more than needed. This capacitor, being also used for the time constant of the muting circuit, affects the starting time.
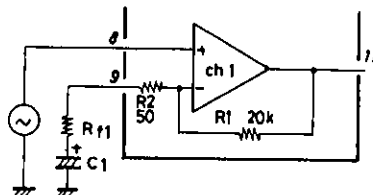
C10: Power source capacitor

Application Circuits

Voltage gain adjust

• Stereo mode

The voltage gain is determined by on-chip resistor R1(R2) and external feed-back resistor Rf as follows:

$$VG = 20\log \frac{R1}{Rf1+R2} \quad [dB]$$

Any voltage gain can be obtained by external resistor Rf.
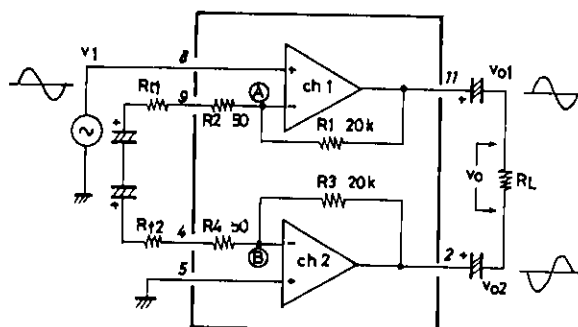

• [BTL1]

Bridge amplifier 1 mode

$$Vo1 \approx \frac{R1}{R2+R4+Rf1+Rf2} \, Vi$$

$$Vo2 \approx -\frac{R3}{R2+R4+Rf1+Rf2} \, Vi$$

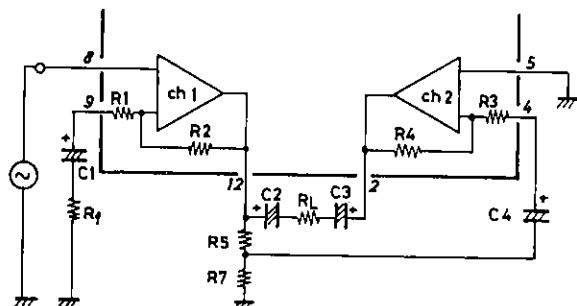$$Vo = Vo1 - Vo2$$

$$= \frac{R1+R3}{R2+R4+Rf1+Rf2} \, Vi$$

$$\therefore VG = 20\log \frac{Vo}{Vi} = 20\log \frac{R1+R3}{R2+R4+Rf1+Rf2} \quad [dB]$$

Assuming R2=R4=50ohms, R1=R3=20kohms and Rf1=Rf2, the voltage gain is obtained by:

$$VG = 20\log \frac{R1}{Rf1+R2} \quad [dB]$$

[BTL2]

Bridge amplifier 2 mode

The CH1 is a noninverting amplifier and the CH2 is an inverting amplifier. The total voltage gain, being apparently higher than that of the CH1 by 6dB, is approximately calculated by the following formula.

$$VG = 20\log \, R2/R1 + 6 \quad (dB)$$

To reduce the voltage gain, Rf is connected and the following formula is used.

$$VG = 20\log \, R2/Rf + R1 + 6 \quad (dB)$$

## Proper Cares in Using LA4550-applied Set

1. If the transformer regulation is not as specified, the supply voltage drops momentarily when the motor of an AC-powered set is turned ON. In this case, hum noise may be generated. So, be careful of the transformer regulation.

2. DC muting

To apply DC muting by controlling the NF pin, it is recommended to use the circuit configuration shown right. The potential at point (A) is set to 3.5 to 4V.
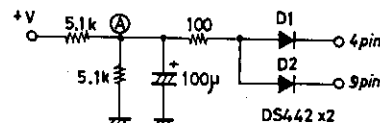
3. Pop noise
   If pop noise generated at the time of power ON/OFF disturbs you, connect a
   resistor of approximately 620ohms across the middle point
   and GND.
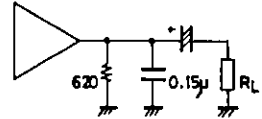
4. Slider contact noise of variable resistor
   Since the input circuit uses PNP transistors, no input coupling capacitor
   is required. However, if slider contact noise of the variable resistor
   presents any problem, connect a capacitor in series with input.

Thermal Design

Since the DIP-12F package is such that the Cu-foiled area of the printed
circuit board is used to dissipate heat, make the Cu-foiled area in the
vicinity of the heat sink of the IC as large as possible when designing the
printed circuit board. The use of the Cu-foiled area indicated by shading in
the above-mentioned sample printed circuit pattern makes it possible to
dissipate more heat. Power dissipation Pd is increased depending on the
supply voltage and load. So, it is recommended to use the printed circuit
board together with the heat sink. The following is a formula to be used to
calculate Pd (for stereo use). For AC power supply, however, it is recom-
mended to actually measure Pd on the transformer of each set. For bridge
amplifier use, Pd is calculated at 1/2 of the load.

(1) DC power supply

$$P_{d\ max} = \frac{V_{CC}^2}{\pi^2 R_L} + I_{cco} \cdot V_{CC} \quad \text{(For stereo use).......(1)}$$

(2) AC power supply

V_{CC2} : Supply voltage at quiescent mode
$V_{CC}(Pd)$: Supply voltage at Pd max
V_{CC1} : Supply voltage at maximum output
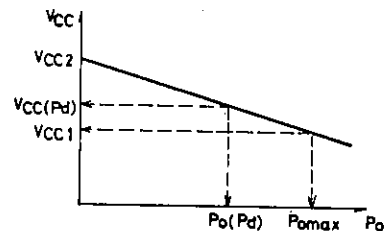r : Voltage regulation $\dfrac{V_{CC2}-V_{CC1}}{V_{CC1}}$

I_{cco} : Quiescent current

Supply voltage regulation

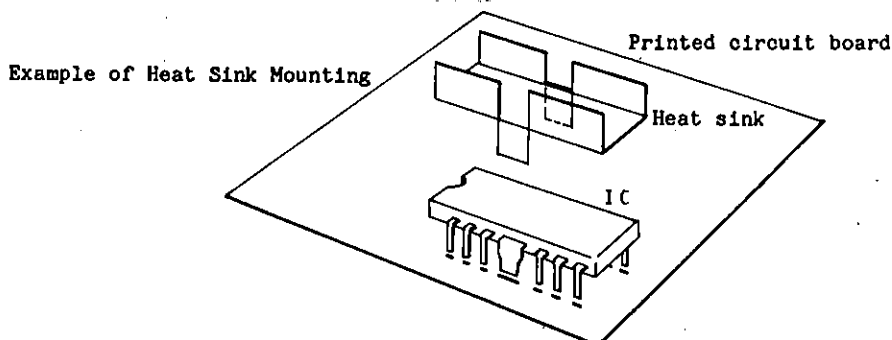$$P_{d\ max} = \frac{V_{CC}(Pd)^2}{\pi^2 R_L} + I_{cco} \cdot V_{CC}(Pd) \quad \text{(For stereo use).......(2)}$$
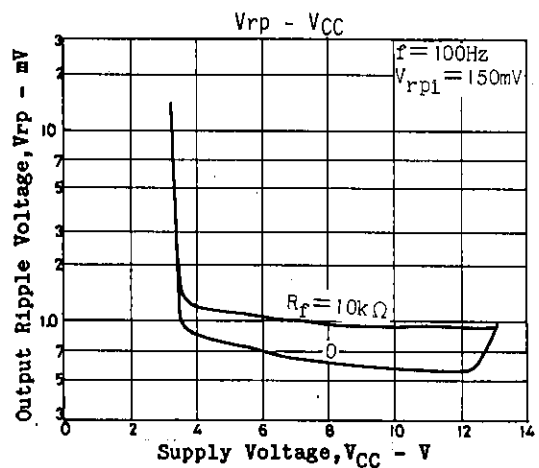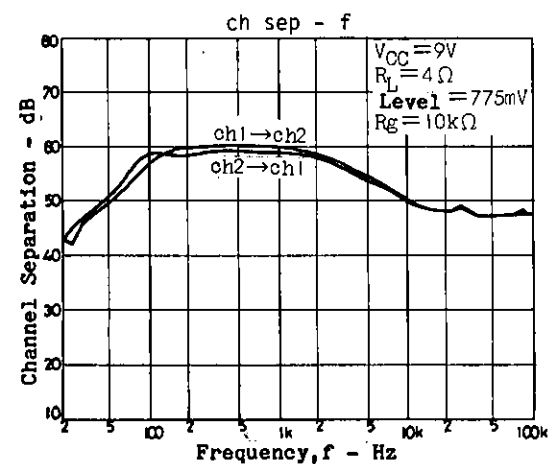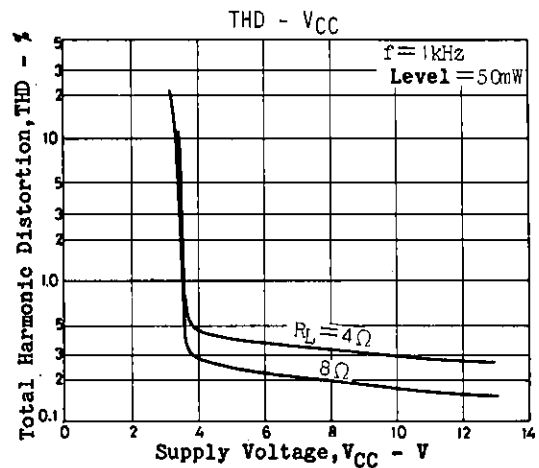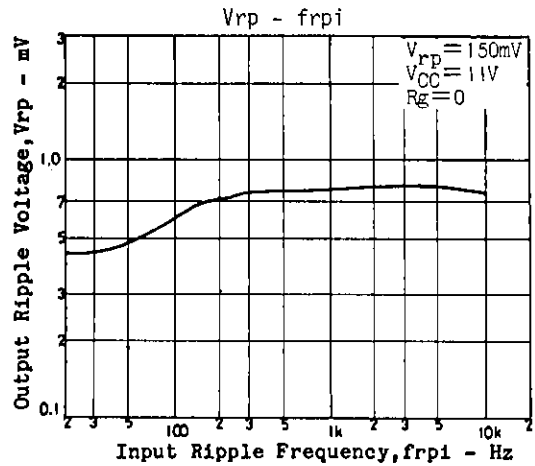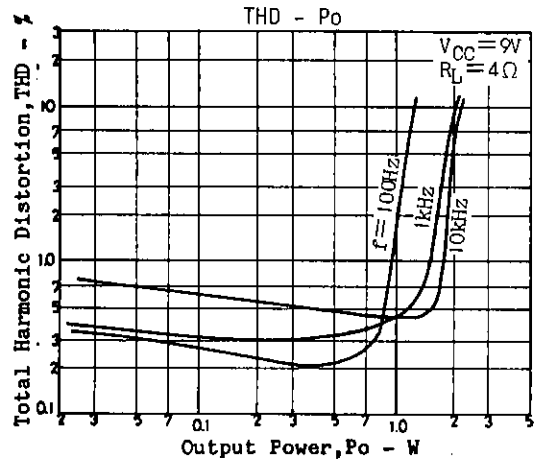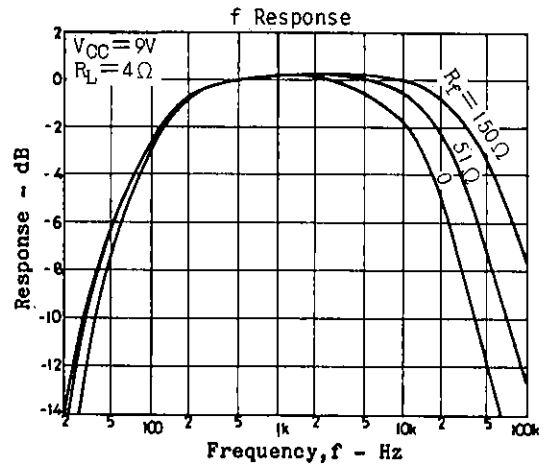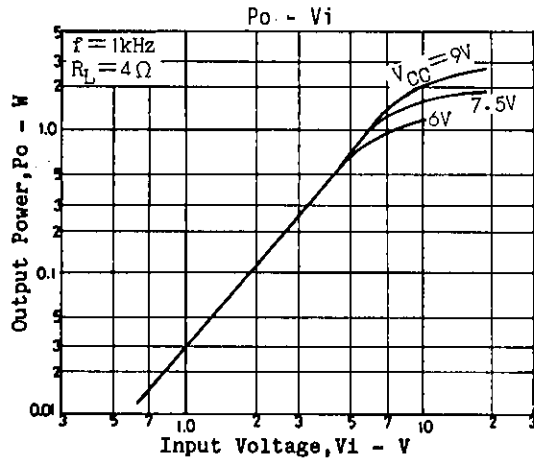
where

$$V_{CC}(Pd) = \frac{(1+r)V_{CC1}}{1 + \dfrac{r \cdot V_{CC1}}{\sqrt{2} \cdot \pi \cdot R_L} \times \sqrt{\dfrac{R_L}{P_{o\ max}}}}$$

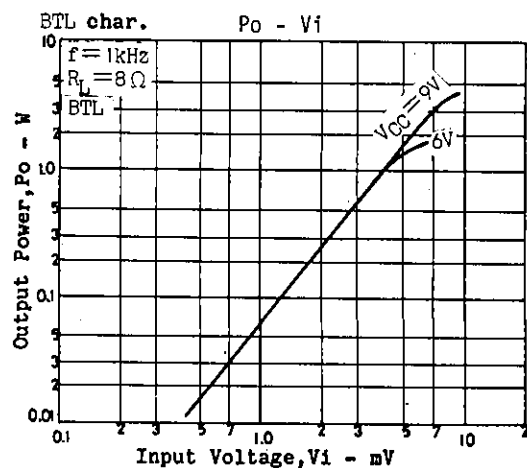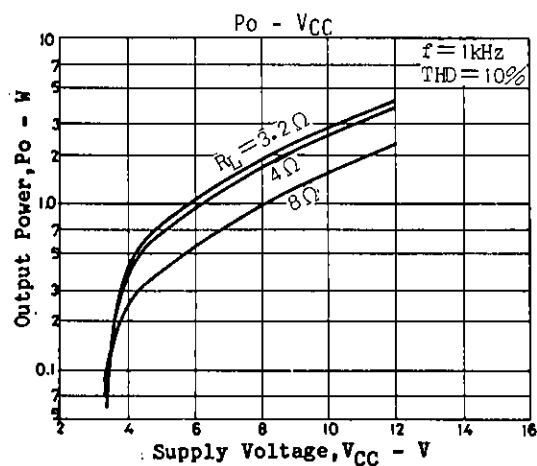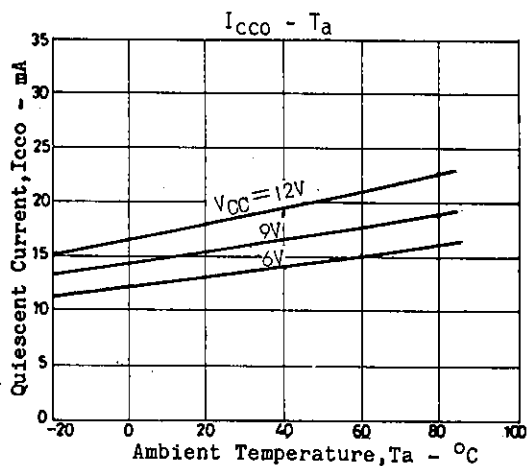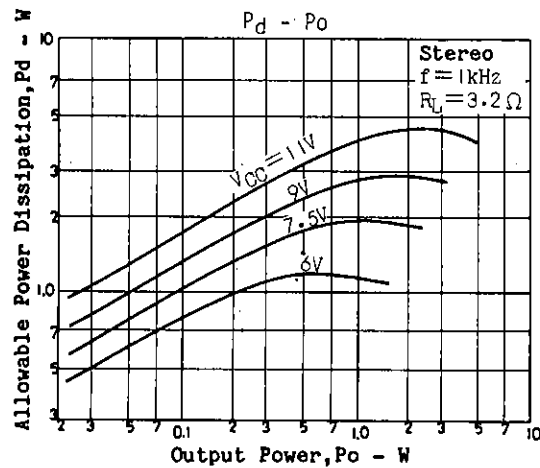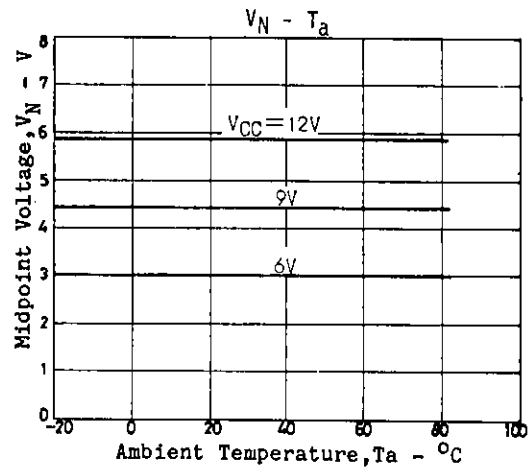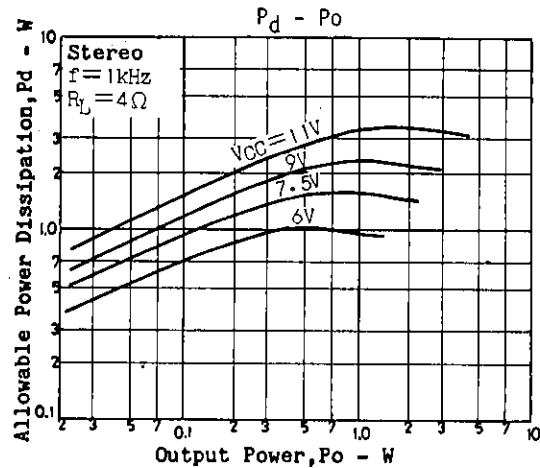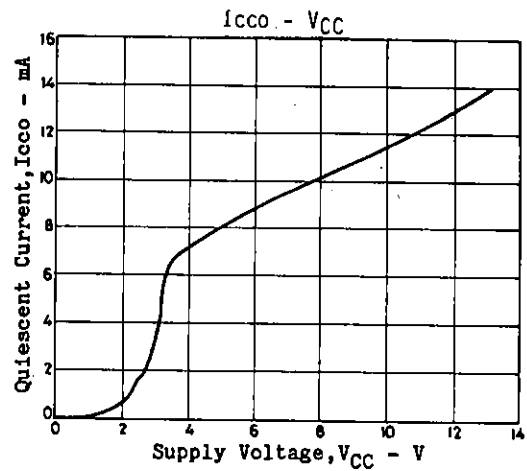Example of Heat Sink Mounting Method
The heat sink must be of such a shape as to be able to dissipate heat from the
IC plastic area and fin area and is soldered to the printed circuit board as
shown below. For the size of the heat sink, refer to the Pd-Ta characteristic.
The material of the heat sink is recommended to be copper or iron which is
solderable. It is recommended to apply silicone grease to the IC plastic area
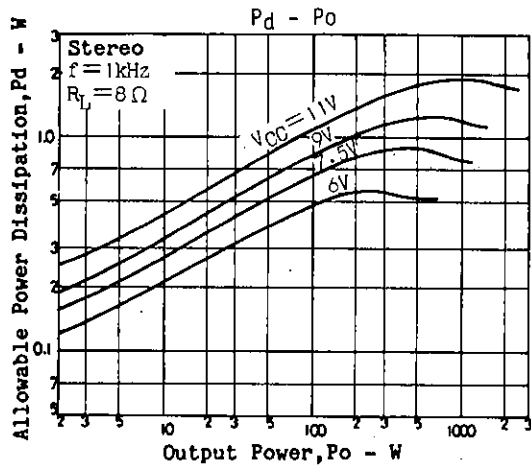to reduce thermal resistance between the heat sink and the IC plastic area.

Example of Heat Sink Mounting

Po - Vi

f = 1kHz
$R_L = 4\Omega$

$V_{CC} = 9V$
7.5V
6V

Output Power, Po - W

Input Voltage, Vi - V

f Response

$V_{CC} = 9V$
$R_L = 4\Omega$

$R_f = 150\Omega$
51Ω
0

Response - dB

Frequency, f - Hz

THD - Po

$V_{CC} = 9V$
$R_L = 4\Omega$

f = 100Hz
1kHz
10kHz

Total Harmonic Distortion, THD - %

Output Power, Po - W

Vrp - frpi

$V_{rp} = 150mV$
$V_{CC} = 11V$
Rg = 0

Output Ripple Voltage, Vrp - mV

Input Ripple Frequency, frpi - Hz

THD - f

$V_{CC} = 9V$
$R_L = 4\Omega$
Level = 250mW

$R_f = 0, 51dB$
$R_f = 150\Omega, 40dB$
$R_f = 51\Omega, 45dB$

Total Harmonic Distortion, THD - %

Frequency, f - Hz

THD - V_{CC}

f = 1kHz
Level = 50mW

$R_L = 4\Omega$
8Ω

Total Harmonic Distortion, THD - %

Supply Voltage, V_{CC} - V

ch sep - f

$V_{CC} = 9V$
$R_L = 4\Omega$
Level = 775mV
Rg = 10kΩ

ch1→ch2
ch2→ch1

Channel Separation - dB

Frequency, f - Hz

Vrp - V_{CC}

f = 100Hz
$V_{rp1} = 150mV$

$R_f = 10k\Omega$
0

Output Ripple Voltage, Vrp - mV

Supply Voltage, V_{CC} - V

LA4550

Pd – Po (Stereo, f=1kHz, RL=8Ω)

Icco – VCC

Pd – Po (Stereo, f=1kHz, RL=4Ω)

VN – Ta

Pd – Po (Stereo, f=1kHz, RL=3.2Ω)

Icco – Ta

Po – VCC (f=1kHz, THD=10%)

BTL char. Po – Vi (f=1kHz, RL=8Ω, BTL)

THD – Po

Total Harmonic Distortion, THD – %

$V_{CC}=6V$
$R_L=4\Omega$

100Hz
1kHz

$f=10kHz$

Output Power, Po – W

P_d – Po

Allowable Power Dissipation, Pd – W

$f=1kHz$
$R_L=4\Omega$
BTL

$V_{CC}=7.5V$
6V

Output Power, Po – W

f Response

Response – dB

$V_{CC}=9V, R_L=8\Omega$
$6V, 4\Omega$

$VG=56dB$
BTL

Frequency, f – Hz

Po – V_{CC}

Output Power, Po – W

$f=1kHz$
$THD=10\%$
$R_L=8\Omega$
BTL

Supply Voltage, V_{CC} – V

THD – f

Total Harmonic Distortion, THD – %

$VG=56dB$
BTL

$V_{CC}=6V, R_L=4\Omega$, Level 125mW
$9V, 8\Omega, 250mW$

Frequency, f – Hz

Po – V_{CC}

Output Power, Po – W

$f=1kHz$
$THD=10\%$
$R_L=4\Omega$
BTL

Supply Voltage, V_{CC} – V

P_d – Po

Allowable Power Dissipation, Pd – W

$R_L=8\Omega$
$f=1kHz$
BTL

$V_{CC}=11V$
9V
7.5V
6V

Output Power, Po – W

Proper Cares in Using IC

1. If the IC is used in the vicinity of the maximum ratings, even a slight variation in conditions may cause the maximum ratings to be exceeded, thereby leading to breakdown. Allow an ample margin of variation for supply voltage, etc. and use the IC in the range where the maximum ratings are not exceeded.
2. Pin-to-pin short
   If power is applied when the space between pins is shorted, breakdown or deterioration may occur. When mounting the IC on the board or applying power, make sure that the space between pins is not shorted with solder, etc.
3. Load short
   If the IC is used with the load shorted for a long time, breakdown or deterioration may occur. Be sure not to short the load.
4. When the IC is used in radios or radio cassette tape recorders, keep a good distance between IC and bar antenna.
5. When making the board, refer to the sample printed circuit pattern.
6. It should be noted that some plug jacks to be used for connecting to the external speaker are such that both poles are shorted once when connecting.