

**STK4048XI**

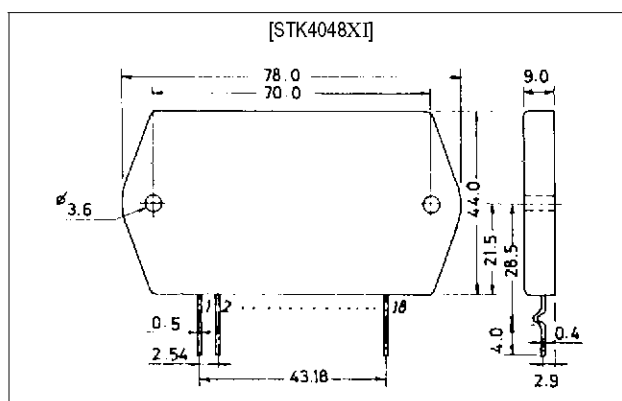
## AF Power Amplifier (Split Power Supply) (150W min, THD = 0.008%)

### Features

- The use of a current mirror circuit, cascode circuit, pure complementary circuit provides low distortion (THD= 0.008%/100kHz LPF ON).
- Possible to design electronic supplementary circuits (pop noise muting at the time of power ON/OFF, load short protector, thermal shutdown)

### Package Dimensions

unit: mm

**4051A**

### Specifications

Maximum Ratings at  $T_a = 25^\circ\text{C}$ 

| Parameter                       | Symbol               | Conditions           | Ratings                | Unit               |
|---------------------------------|----------------------|----------------------|------------------------|--------------------|
| Maximum supply voltage          | $V_{CC \text{ max}}$ |                      | $\pm 87$               | V                  |
| Thermal resistance              | $\theta_{j-c}$       | Per power Transistor | 1.2                    | $^\circ\text{C/W}$ |
| Junction temperature            | $T_j$                |                      | 150                    | $^\circ\text{C}$   |
| Operating substrate temperature | $T_c$                |                      | 125                    | $^\circ\text{C}$   |
| Storage temperature             | $T_{stg}$            |                      | $-30 \text{ to } +125$ | $^\circ\text{C}$   |

Recommended Operating Conditions at  $T_a = 25^\circ\text{C}$ 

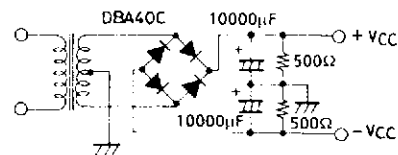
| Parameter                  | Symbol   | Conditions | Ratings  | Unit     |
|----------------------------|----------|------------|----------|----------|
| Recommended supply voltage | $V_{CC}$ |            | $\pm 60$ | V        |
| Load resistance            | $R_L$    |            | 8        | $\Omega$ |

**Operating Characteristics** at  $T_a = 25^\circ\text{C}$ ,  $V_{CC} = \pm 60\text{V}$ ,  $R_L = 8\Omega$ ,  $V_G = 40\text{dB}$ ,  $R_g = 600\Omega$ , 100kHz LPF ON,  
 $R_L$  : noninductive load

| Parameter                 | Symbol     | Conditions                                          | min | typ       | max   | Unit      |
|---------------------------|------------|-----------------------------------------------------|-----|-----------|-------|-----------|
| Quiescent current         | $I_{CCO}$  | $V_{CC} = \pm 72\text{V}$                           | 15  |           | 120   | mA        |
| Output power              | $P_o$      | THD = 0.008%,<br>$f = 20\text{Hz to } 20\text{kHz}$ | 150 |           |       | W         |
| Total harmonic distortion | THD        | $P_o = 1.0\text{W}$ , $f = 1\text{kHz}$             |     |           | 0.008 | %         |
| Frequency response        | $f_L, f_H$ | $P_o = 1.0\text{W}$ , $+0$<br>$-3$ dB               |     | 20 to 50k |       | Hz        |
| Input impedance           | $r_i$      | $P_o = 1.0\text{W}$ , $f = 1\text{kHz}$             |     | 55        |       | $k\Omega$ |
| Output noise voltage      | $V_{NO}^*$ | $V_{CC} = \pm 72\text{V}$ , $R_g = 10k\Omega$       |     |           | 1.2   | mVrms     |
| Neutral voltage           | $V_N$      | $V_{CC} = \pm 72\text{V}$                           | -70 | 0         | +70   | mV        |

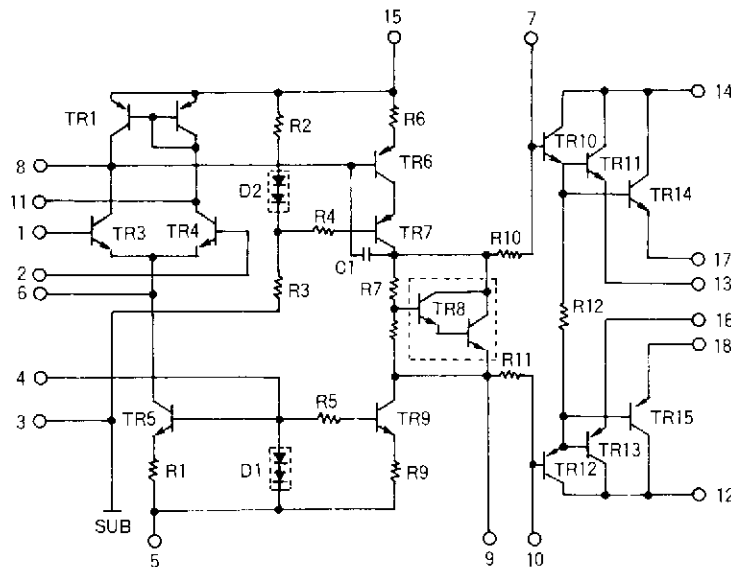
Notes. For power supply at the time of test, use a constant-voltage power supply unless otherwise specified.

\*The output noise voltage is represented by the peak value on rms scale (VTVM) of average value indicating type. The noise voltage waveform includes no flicker noise. For measurement of the output noise voltage, use the specified transformer power supply shown right.

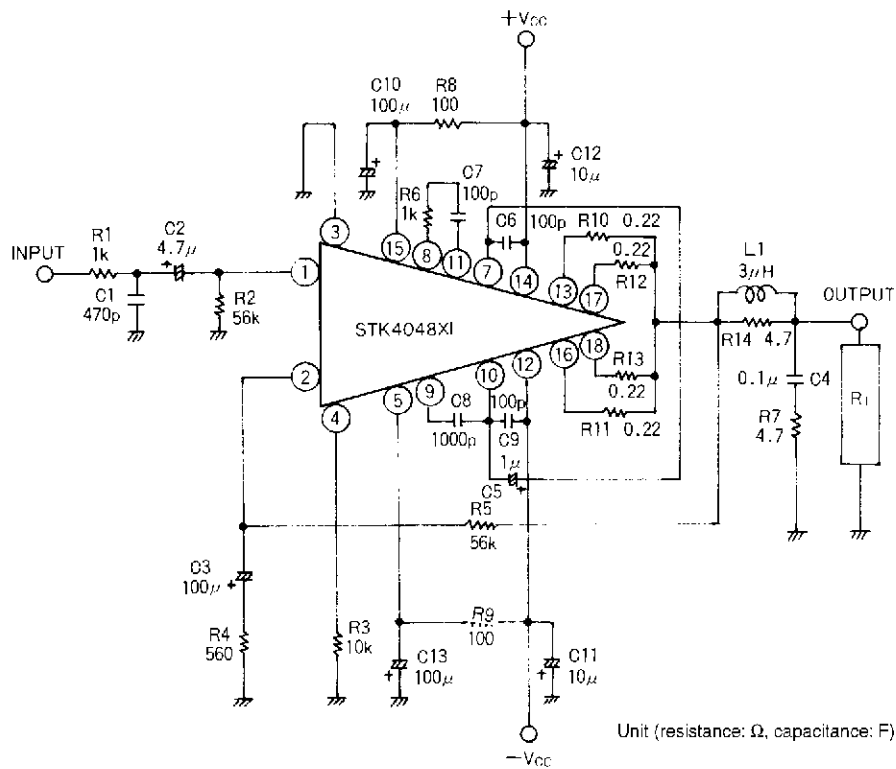


Specified Transformer Power Supply  
(Equivalent to MG250)

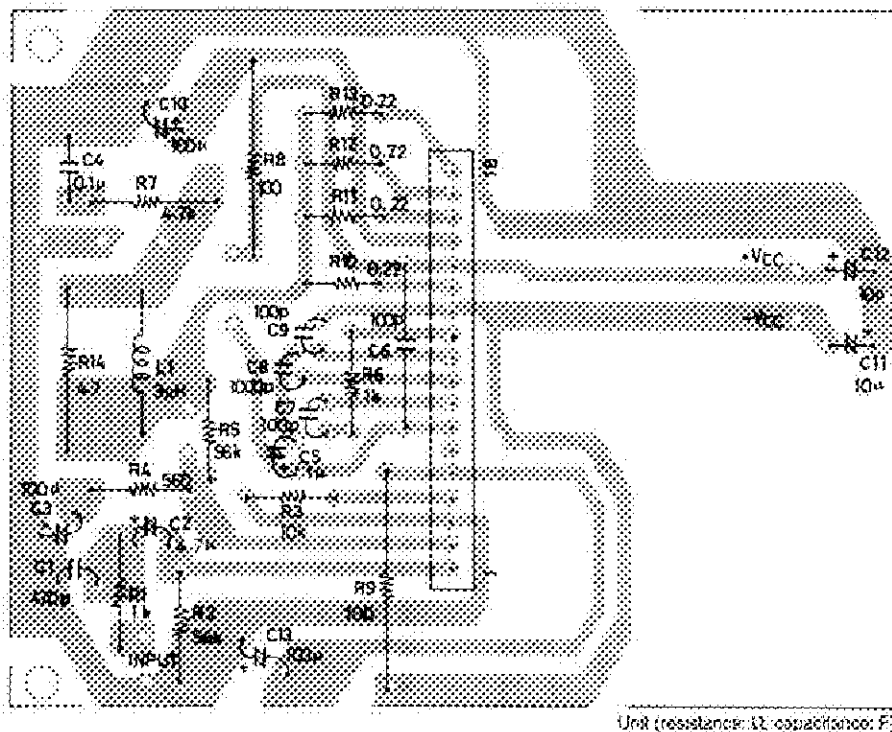
## Equivalent Circuit

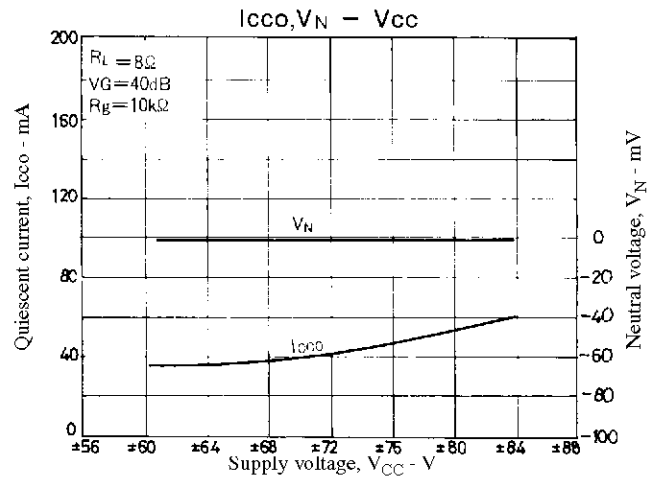
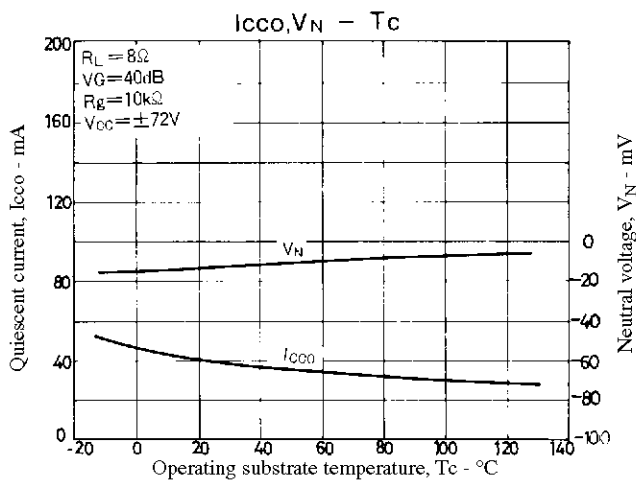
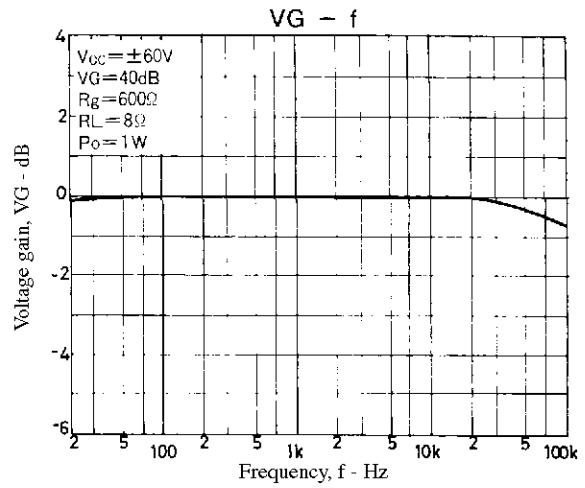
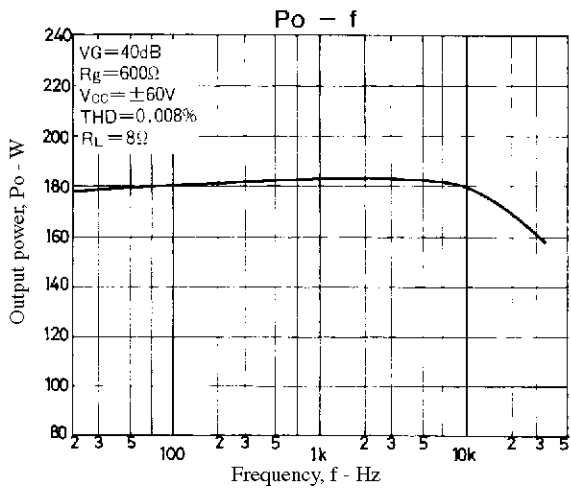
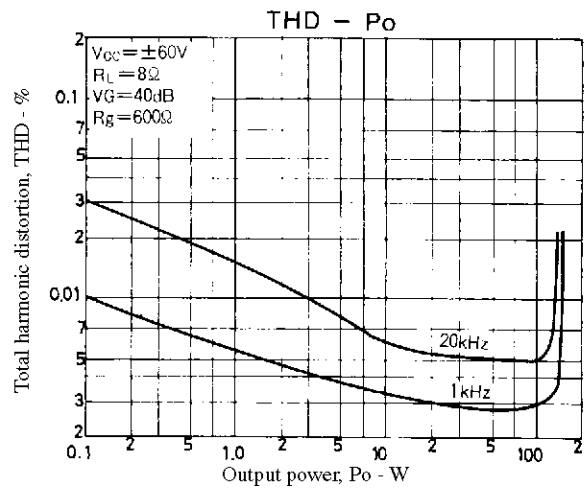
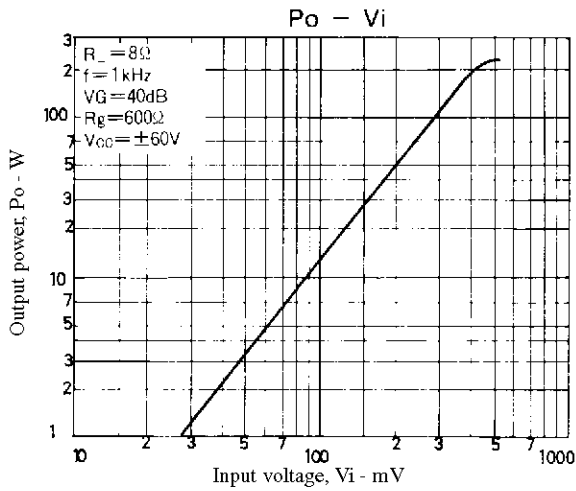


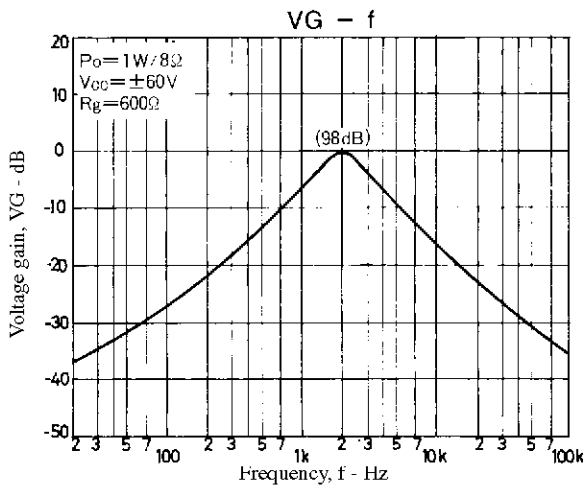
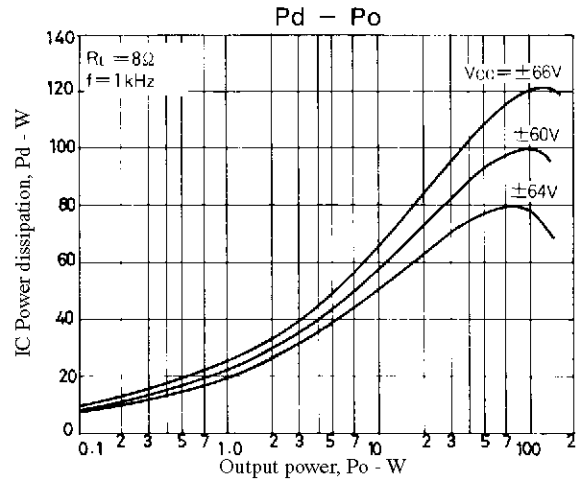
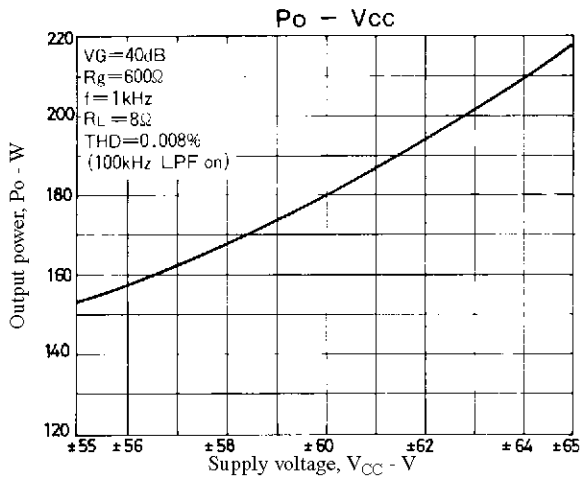
**Sample Application Circuit: 150W min Single-Channel AF Power Amplifier**



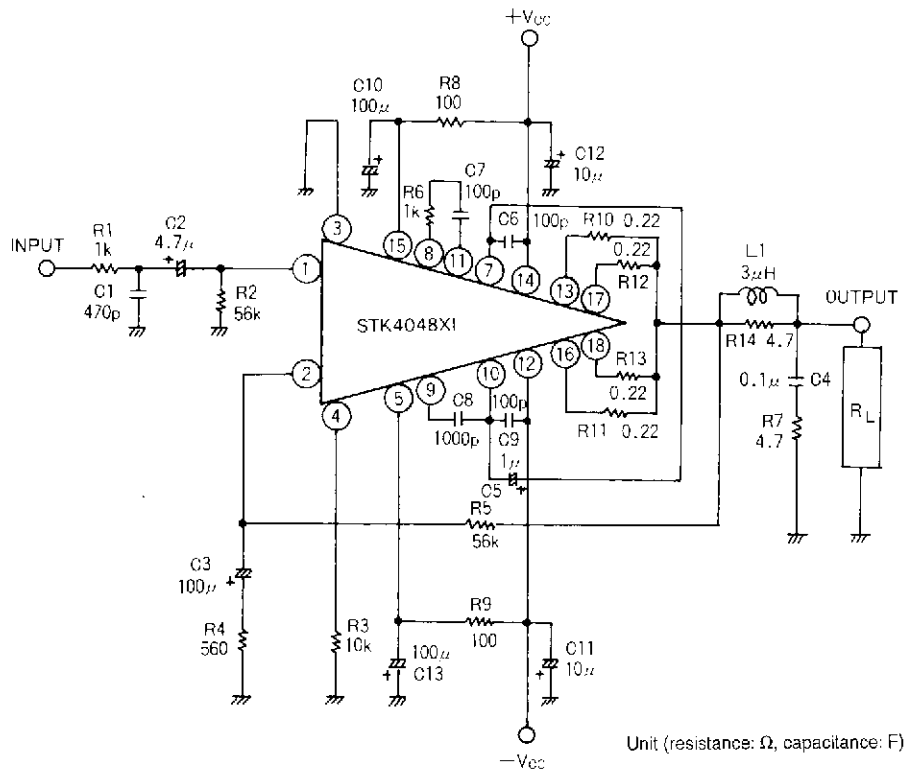
**Sample Printed Circuit Pattern for Application Circuit (Cu-foiled side)**

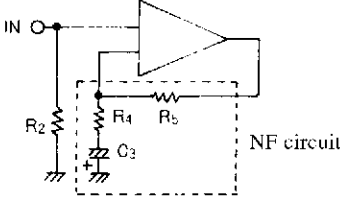






## Description of External Parts



|                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|----------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| R1, C1               | Input filter circuit<br>• Used to reduce noise at high frequencies.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| C2                   | Input coupling capacitor<br>• Used to block DC current. When the reactance of the capacitor increases at low frequencies, the dependence of 1/f noise on signal source resistance causes the output noise to worsen. It is better to decrease the reactance.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| R2                   | Input bias resistor<br>• Used to bias the input pin to zero.<br>• Affects $V_N$ stability. (See NF circuit.)<br>• Because of differential input, this resistor fixes the input resistance practically.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| R4, R5<br>C3 (C2)    | <p>NFB circuit (AC NF circuit). It is desirable that the error of the resistor value is 1% or less.</p>  <p>C3 : Capacitor for AC NF<br/>R4, R5 : Used to set VG</p> <p>• VG setting obtained by using R4, R5 ..... <math>VG = \log 20 \cdot \frac{R_5}{R_4}</math> (40dBisrecommended)</p> <p>• Low cutoff frequency setting obtained by using, R4, C3. .... <math>f_L = \frac{1}{2\pi \cdot R_4 \cdot C_3}</math> (Hz)</p> <p>• Change of VG setting</p> <ul style="list-style-type: none"> <li>• It is desirable to change R4. In this case, the low cutoff frequency setting needs to be rechecked.</li> <li>• When VG setting is changed by changing R5, R5 must be made equal to R2 to ensure <math>V_N</math> balance. If the resistor value is increased more than the existing value, it may be hard to ensure <math>V_N</math> balance and the temperature characteristic of <math>V_N</math> may be also deteriorated.</li> </ul> |
| R3                   | First-stage constant-current bias resistor                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| R6, C7               | Used for oscillation blocking and phase compensation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| R7, C4               | Used for oscillation blocking and phase compensation<br>(C4 : A polyester film capacitor is recommended.)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| C6, C9               | Used for oscillation blocking and phase compensation<br>(Must be connected near the pin)<br>C6 : Power amp on (+) side    C9 : Power amp on (–) side                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| C4                   | Used for oscillation blocking and phase compensation<br>(Used for oscillation blocking before clip)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| C5                   | Used for oscillation blocking and distortion improvement                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| C8, C10              | Ripple filter circuit on (+) side                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| R9, C13              | Ripple filter circuit on (–) side                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| C11, C12             | Used for oscillation blocking<br>• Used to decrease the power supply impedance to operate the IC stably. Must be connected near the IC pin. It is desirable to use an electrolytic capacitor.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| L1, R14              | Used for oscillation blocking                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| R10, R11<br>R12, R13 | Output limiting resistors                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |

## Thermal Design

The IC power dissipation of the STK4048XI at the IC-operated mode is 100W max. at load resistance  $8\Omega$  for continuous sine wave as shown in Figure 1.

In an actual application where a music signal is used, it is impractical to estimate the power dissipation based on the continuous signal as shown right, because too large a heat sink must be used. It is reasonable to estimate the power dissipation as  $1/10 P_o$  max. (EIAJ).

That is,  $P_d = 65W$  at  $8\Omega$

Thermal resistance  $\theta_{c-a}$  of a heat sink for this IC power dissipation ( $P_d$ ) is fixed under conditions 1 and 2 shown below.

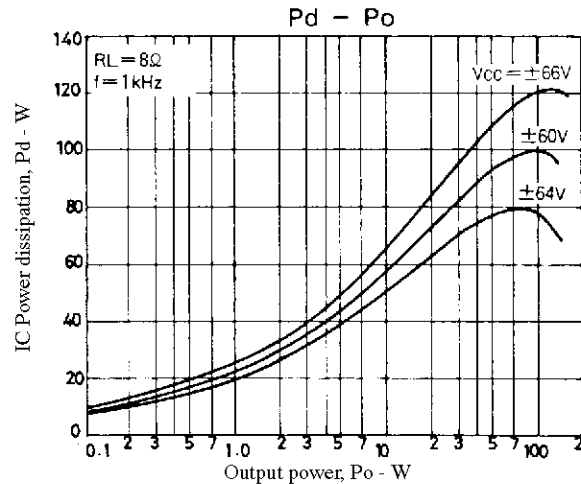


Figure 1. STK4048XI  $P_d - P_o$  ( $R_L = 8\Omega$ )

$$\text{Condition 1: } T_c = P_d \times \theta_{c-a} + T_a \leq 125^\circ\text{C} \dots\dots\dots (1)$$

where  $T_a$  : Specified ambient temperature  
 $T_c$  : Operating substrate temperature

$$\text{Condition 2: } T_j = P_d \times (\theta_{c-a}) + P_d/4 \times (\theta_{j-c}) + T_a \leq 150^\circ\text{C} \dots\dots\dots (2)$$

where  $T_j$  : Junction temperature of power transistor

Assuming that the power dissipation is shared equally among the four power transistors, thermal resistance  $\theta_{j-c}$  is  $1.2^\circ\text{C/W}$  and

$$P_d \times (\theta_{c-a} + 1.2/4) + T_a \leq 150^\circ\text{C} \dots\dots\dots (3)$$

Thermal resistance  $\theta_{c-a}$  of a heat sink must satisfy inequalities (1) and (3).

Figure 2 shows the relation between  $P_d$  and  $\theta_{c-a}$  given from (1) and (3) with  $T_a$  as a parameter.

[Example] The thermal resistance of a heat sink is obtained when the ambient temperature specified for a stereo amplifier is  $50^\circ\text{C}$ .

Assuming  $V_{CC} = \pm 60V$ ,  $R_L = 8\Omega$ ,  
 $R_L = 8\Omega$  :  $P_d = 65W$  at  $1/10 P_o$  max.

The thermal resistance of a heat sink is obtained from Figure 2.

$R_L = 8\Omega$  :  $\theta_{c-a1} = 1.15^\circ\text{C/W}$

$T_j$  when a heat sink is used is obtained from (3).

$R_L = 8\Omega$  :  $T_j = 144.3^\circ\text{C}$

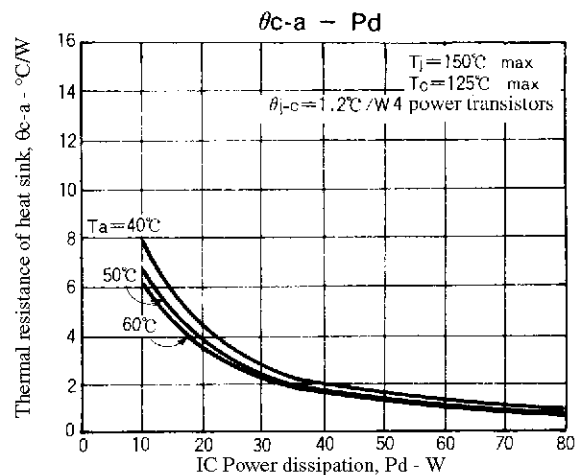


Figure 2. STK4048XI  $\theta_{c-a} - P_d$

This design is based on the use of a constant-voltage regulated power supply.  $P_d$  differs when a transformer power supply is used. Redesign must be made based on  $P_d$  that suits the regulation of each transformer.

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