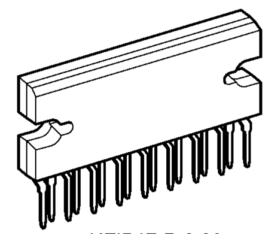
TOSHIBA Bipolar Linear Integrated Circuit Silicon Monolithic

TA8221AHQ,TA8221ALQ

30W BTL × 2Ch Audio Power Amplifier

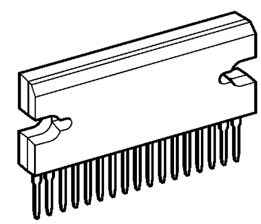
The thermal resistance θj−T of TA8221AHQ, TA8221ALQ package designed for low thermal resistance, has a high efficiency of heat radiation.
The temperature rise of chip can be reduced, and the influence from the degradation of the features due to the temperature rise at the high output can also be reduced.
This stereo audio power IC, designed for car audio use, has two built−in channels to reduce the characteristic difference between L and R channels.
It also contains various kind of protection.

TA8221AHQ



HZIP17-P-2.00

TA8221ALQ



HSIP17-P-2.00

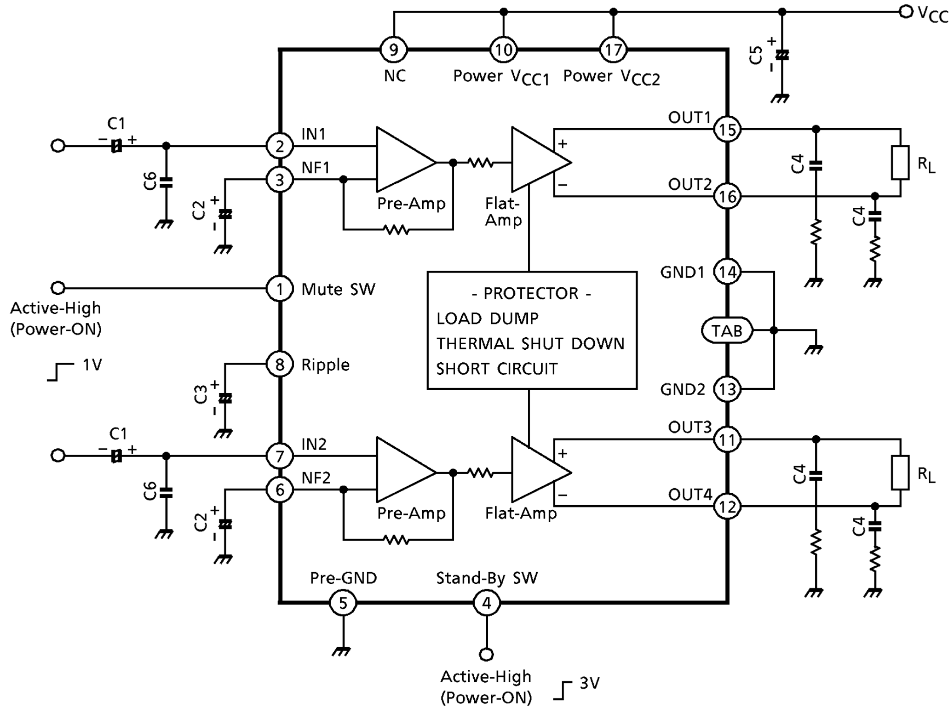
Weight
HZIP17−P−2.00 : 9.8g (typ.)
HSIP17−P−2.00 : 9.8g (typ.)

Features

- Low thermal resistance
  : θj−T = 1.5°C / W (infinite heat sink)
- High power
  : $P_{OUT\ (1)}$ = 30W (typ.) / channel
  (V_{CC} = 14.4V, f = 1kHz, THD = 10%, R_L =2Ω)
  $P_{OUT\ (2)}$ = 26W (typ.) / channel
  (V_{CC} = 13.2V, f = 1kHz, THD = 10%, R_L = 2Ω)
  $P_{OUT\ (3)}$ = 19W (typ.) / channel
  (V_{CC} = 13.2V, f = 1kHz, THD = 10%, R_L = 4Ω)
- Low distortion ratio: THD = 0.04% (typ.) (V_{CC} = 13.2V, f = 1kHz, P_{OUT} = 1W, R_L = 4Ω, G_V = 50dB)
- Low noise: V_{NO} = 0.30mV_{rms} (typ.) (V_{CC} = 13.2V, R_L = 4Ω, G_V 50dB, R_g = 0Ω, BW = 20Hz~20kHz)
- Built−in stand−by function (with pin(4) set at low, power is turned off.): I_{SB} = 100μA (typ.)
- Built−in muting function (with pin(1) set at low, power is turned off.)
- Built−in various protection circuits
  Protection circuits: Thermal shut down, Over voltage, Out→V_{CC} short, Out→GND short and Out−Out short.
- Operating supply voltage: $V_{CC\ (opr)}$ = 9~18V

Block Diagram

TA8221AHQ, TA8221ALQ (G_V = 50dB)



Cautions And Application Method
(description is made only on the single channel.)

1. Voltage gain adjustment

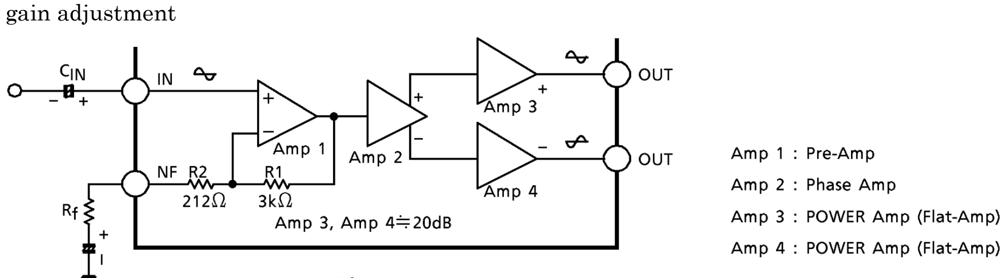


Fig.1

This IC has the amplifier construction as shown Fig.1. The pre–amp (amp 1) is provided to the primary stage, and the input voltage is amplified by the flat amps, amp 3 and amp 4 of each channel through the phase amp (amp 2).

Since the input offset is prevented by pre–amp when V_{CC} is set to on, this circuit can remarkably reduce the pop noise.

The total closed loop gain G_V of this IC can be obtained by expression below when the closed loop voltage gain of amp 1 is G_{V1}.

$$G_{V1} = 20\log\frac{R1 + (R_f + R2)}{R_f + R2}\ (\text{dB}) \quad \ldots\ldots \quad (1)$$

The closed loop voltage gain of power amp, amp 3 and amp 4 is fixed at $G_{V3} \fallingdotseq G_{V4} = 20\text{dB}$.
Therefore, the total closed circuit voltage gain G_V is obtained through BTL connection by the expression below.

$$G_V = G_{V1} + G_{V3} + 6\ (\text{dB}) \quad \ldots\ldots\ldots\ldots\ldots \quad (2)$$

For example, when Rf = 0Ω, G_V is obtained by the expressions (1) and (2) as shown below.

$$G_V \fallingdotseq 24 + 20 + 6 = 50\text{dB}$$

The voltage gain is reduced when R_f is increased. (Fig.2)
With the voltage gain reduced, since (1) the oscillation stability is reduced, and (2) the pop noise changes when V_{CC} is set to on, refer to the items 3 and 4.

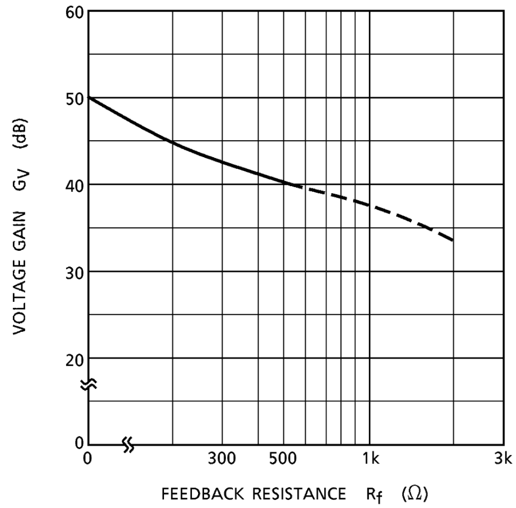


Fig.2

2. Stand–by SW function
   By means of controlling pin(4) (stand–by terminal) to high and low, the power suply can be set to on and off.
   The threshold voltage of pin(4) is set at 2.1V ($3V_{BE}$.),
   and the power supply current is about 100μA (typ.) at the stand–by state.
   Control voltage of pin(4): $V_{(SB)}$

Stand–by	Power	$V_{(SB)}$ (V)
On	Off	0~2
Off	On	3~V_{CC}

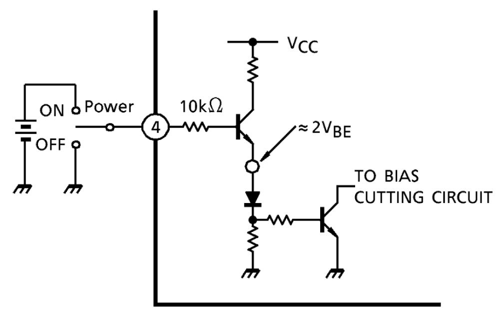
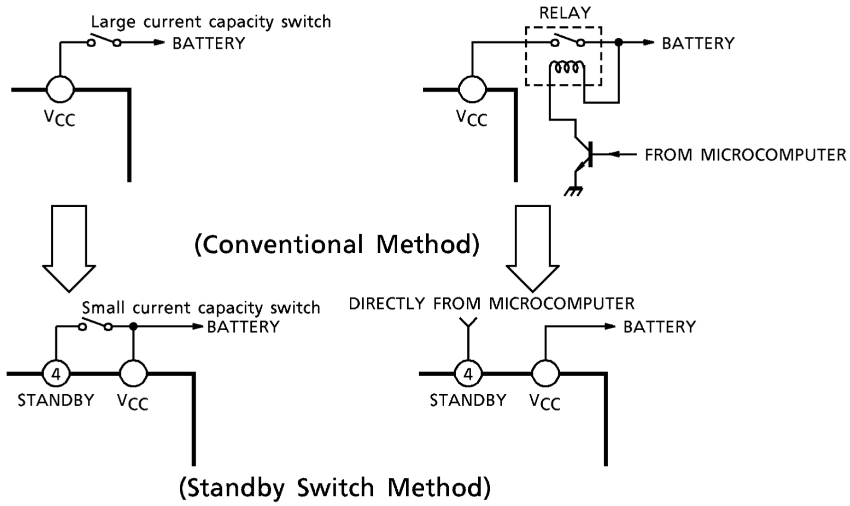


Fig.3 With pin④ set to High, Power is turned ON.

Advantage of stand–by SW
(1) Since V_{CC} can directly be controlled to on / off by the microcomputer, the switching relay can be omitted.
(2) Since the control current is microscopic, the switching relay of small current capacity is satisfactory for switching.



3. Preventive measure against oscillation

For preventing the oscillation, it is advisable to use C4, the condenser of polyester film having small characteristic fluctuation of the temperature and the frequency.
The condenser (C6) between input and GND is effective for preventng oscillation which is generated with a feedback signal from an output stage.
The resistance R to be series applied to C4 is effective for phase correction of high frequency, and improves the oscillation allowance.

(1) Voltage gain to be used (G_V setting)
(2) Capacity value of condenser
(3) Kind of condenser
(4) Layout of printed board

In case of its use with the voltage gain G_V reduced or with the feedback amount increased, care must be taken because the phase–inversion is caused by the high frequency resulting in making the oscillation liable generated.

4. Adjustment of output offset (when the power supply turn on)

As this IC is contructed with DC circuit on the primary stage, it is necessary to lower a input offset or output offset by agreement with the each leading edge time constant of the input voltage in the primary stage and NF terminal voltage.
Concretely, monitor the output DC voltage and vary the capacity value in input condenser and NF condenser (see Fig.4)
(reference) In case of setting the condition (G_V = 40dB) with R_f = 470Ω.

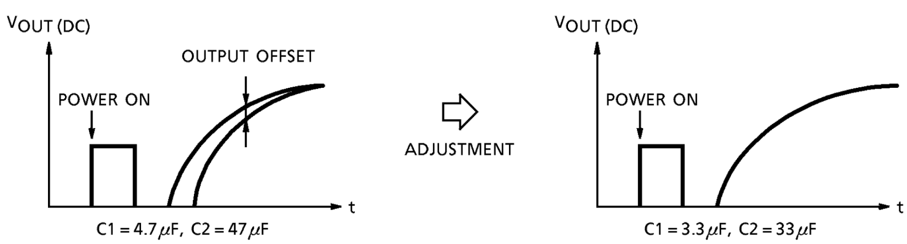


Fig.4

5. Muting function

Through setting pin(1) (mute terminal) at about 1V or less, muting becomes possible.
The interval circuit of IC is shown in Fig.5.
When pin(1) is set to low, Q1 and Q2 are turned to on, the charge of the ripple condenser is discharged and the bias is cut. The mute amount of 60dB or over can be obtained.
Since this muting function rapidly discharge the charge of the ripple filter capacitor of pin(8), the pop noise is generated by the DC fluctuation of the bias section.
Therefore, this muting function is not appropriate to the audio muting but it is effective in muting at V_{CC}→on.

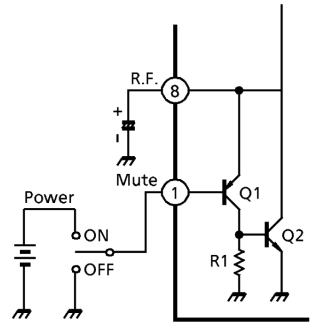


Fig.5 Mute circuit

6. Rapid ripple discharging circuit at the time of V_{CC} off

This circuit is effective in such a mode where the V_{CC} and the stand–by terminals become high / low simultaneously ; for instance, for a pop noise produced when the power is turned on / off repeatedly by operating the ignition key.

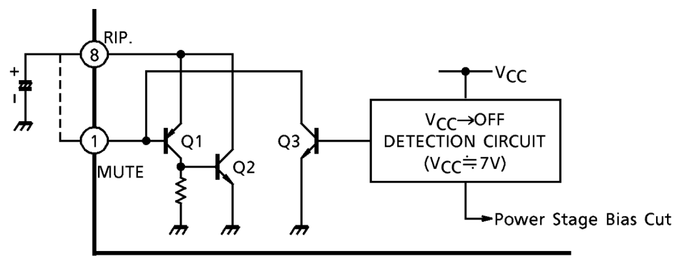


Fig.6

If V_{CC} is off, V_{CC}≒7V is detected internally on IC and

(1) The power stage bias circuit is cut, and
(2) Pin(8) : Ripple capacitor is rapidly discharged by turning Q3 on and then Q1 and Q2 on.

(Precaution 1)

When the stand–by terminal was put to the low level after the ripple rapid discharging circuit was operated (V_{CC}≒7V) at the time when V_{CC} was turned off, a pop noise may be generated. Therefore, V_{CC} which makes the stand–by terminal low shall be set at 8V or above so that (1) the stand–by terminal is put at the low level and (2) the ripple rapid discharging circuit is turned on when V_{CC} is turned off (in order of (1) and (2)).
An example of application is shown in (Fig.7).

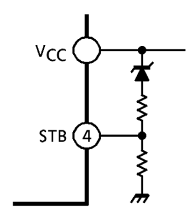


Fig.7

(Precaution 2)

If the falling time constant of the V_{CC} line is large (the fall is gentle), the pop noise may become worse.
In this case, it is possible to prevent the pop noise from beoming worse by reducing the capacity of "ripple rapid discharging circuit at the time of V_{CC} off" accordign to the following steps :

(a) Short pin(1) (mute terminal) and pin(8) (ripple terminal).
(b) Increase the capacity of ripple capacitor of pin(8).

However, it shall be kept in mind that the time for turning the power on becomes longer as the result of step (b).

7. External parts list and description

Sym− bol	Recom− mended Value	Feature	Influence: Smaller Than Recommended Value	Influence: Larger Than Recommended Value	Remarks
C1	4.7μF	DC blocking	Related to pop noise at V_{CC}→on.		Related to gain. Refer to item 4.
C2	47μF	Feedback condenser	Related to pop noise at V_{CC}→on. Determination of low cut−off frequency. $C2 = \frac{1}{2\pi \cdot f_L \cdot R_f}$		
C3	220μF	Ripple reduction	Time constant is small at V_{CC}→on or off.	Time constant is large at V_{CC}→on or off.	
C4	0.12μF	Oscillation prevention	Made liable to oscillate.	Oscillation allowance	Refer to item 3.
C5	1000μF	Ripple filter	For filtering power supply hum and ripple. Large at using AC rectified power supply. Small at using DC power supply.		
C6	1000pF	Oscillation prevention	Oscillation allowance improved. Noise reduction		Refer to item 3.

Maximum Ratings (Ta = 25°C)

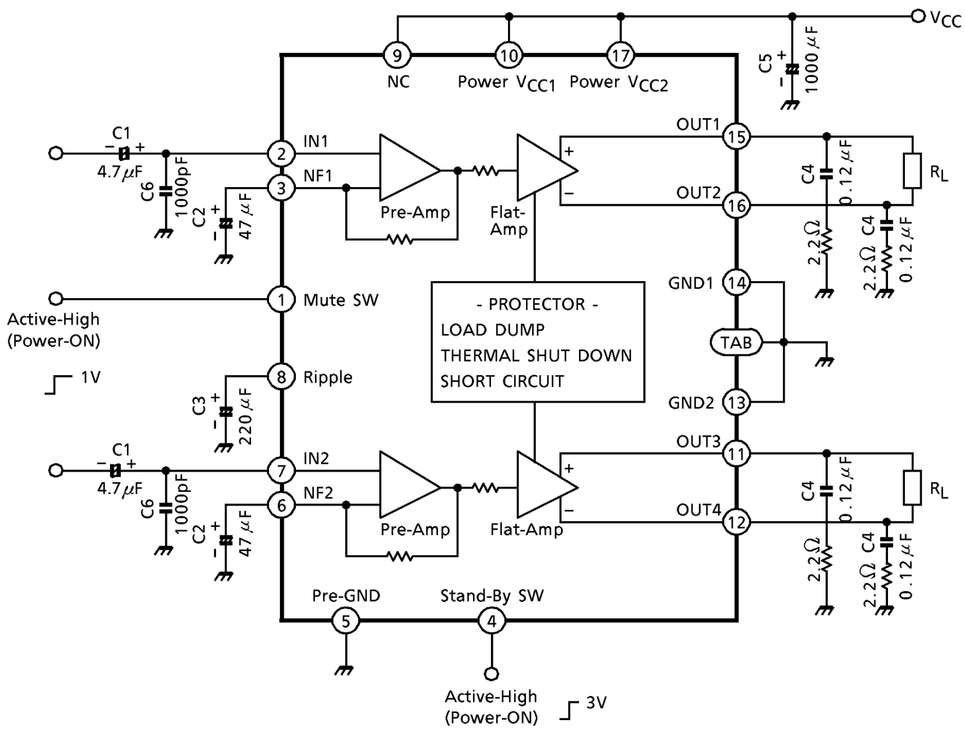
Characteristic	Symbol	Rating	Unit
Peak supply voltage (0.2s)	V_{CC} (surge)	50	V
DC supply voltage	$V_{CC\ (DC)}$	25	V
Operating supply voltage	$V_{CC\ (opr)}$	18	V
Output current (peak)	$I_{O\ (peak)}$	9	A
Power dissipation	P_D	50	W
Operating temperature	T_{opr}	−30~85	°C
Storage temperature	T_{stg}	−55~150	°C

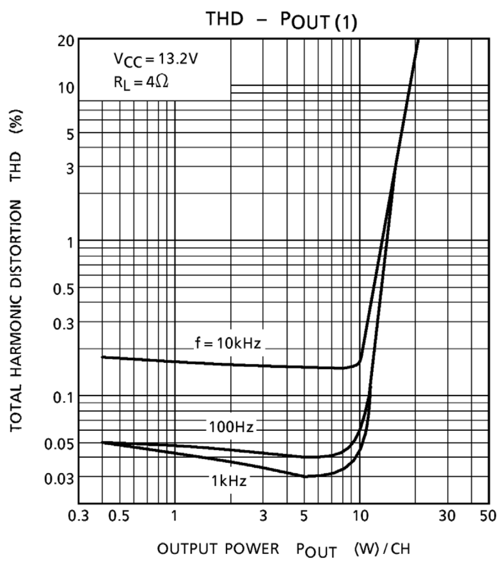
Electrical Characteristics
(unless otherwise specified, V_{CC} = 13.2V, R_L = 4Ω, f = 1kHz, Ta = 25°C)

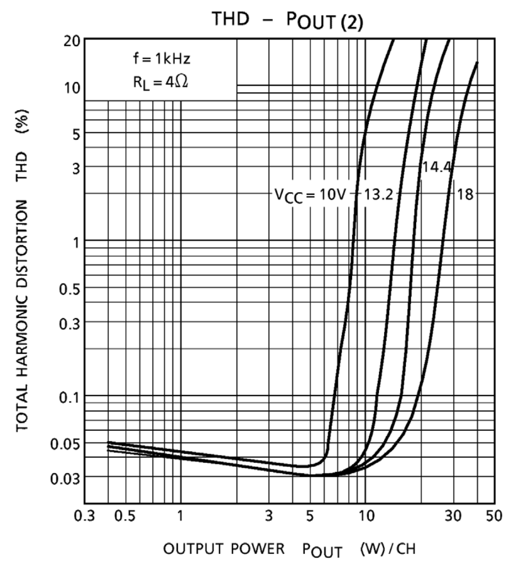
Characteristic	Symbol	Test Cir-cuit	Test Condition	Min.	Typ.	Max.	Unit
Quiescent supply current	I_{CCQ}	—	V_{IN} = 0	—	120	250	mA
Output power	$P_{OUT\ (1)}$	—	V_{CC} = 14.4V, R_L = 2Ω, THD = 10%	—	30	—	W
	$P_{OUT\ (2)}$	—	R_L = 2Ω, THD = 10%	17	26	—	
	$P_{OUT\ (3)}$	—	THD = 10%	16	19	—	
Total harmonic distortion	THD	—	P_{OUT} = 1W	—	0.04	0.4	%
Voltage gain	G_V	—	—	48	50	52	dB
Voltage gain ratio	ΔG_V	—	—	−1.0	0	1.0	dB
Output noise voltage	V_{NO}	—	R_g = 0Ω, BW = 20Hz~20kHz	—	0.3	0.7	mV_{rms}
Ripple rejection ratio	R.R.	—	fripple = 100Hz, R_g = 600Ω	40	54	—	dB
Input resistance	R_{IN}	—	—	—	30	—	kΩ
Output offset voltage	V_{offset}	—	V_{IN} = 0	−100	0	100	mV
Current at stand−by state	I_{SB}	—	—	—	100	150	μA
Cross talk	C.T.	—	R_g = 600Ω, V_{OUT} = 0.775V_{rms} (0dBm)	—	60	—	dB
Pin(4) control voltage	V_{SB}	—	Stand−by → off (power→on)	2.5	—	V_{CC}	V
Pin(1) control voltage	$V_{(mute)}$	—	Mute→on (power→off)	—	1.0	2.0	V

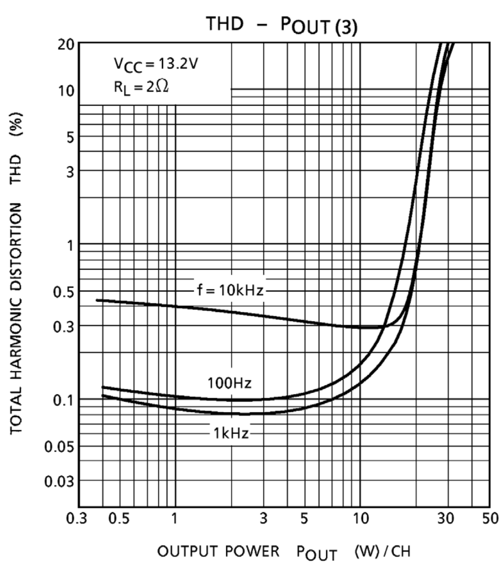
Test circuit

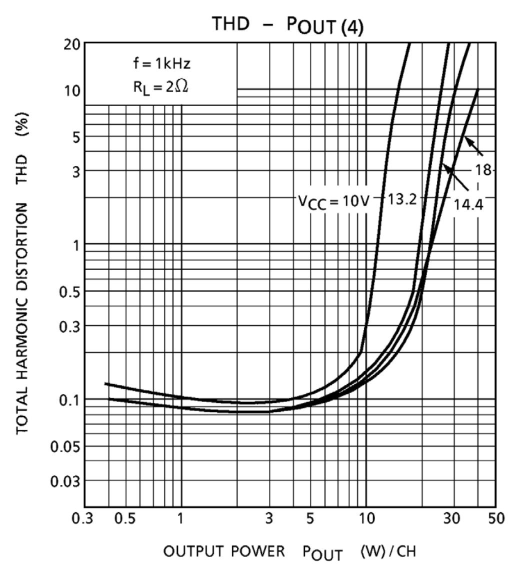
TA8221AHQ, TA8221ALQ (G_V = 50dB)

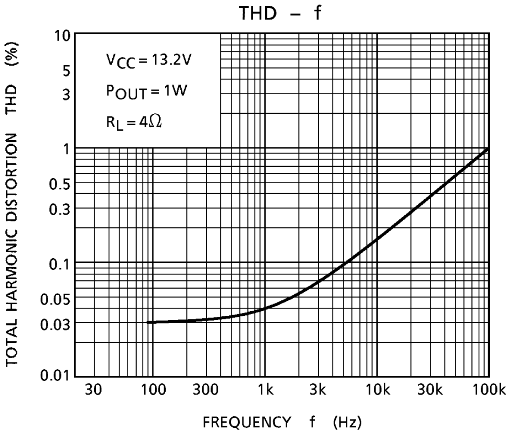


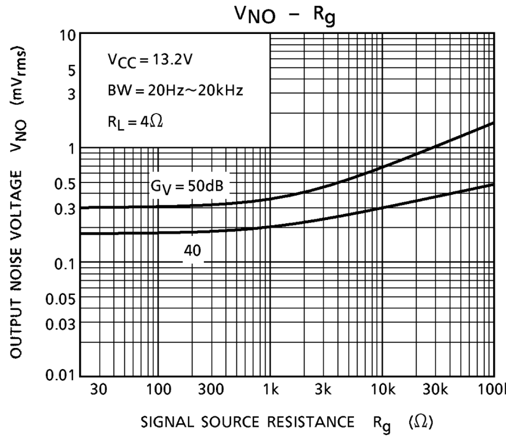

THD – POUT (1)
VCC = 13.2V
RL = 4Ω
f = 10kHz
100Hz
1kHz
TOTAL HARMONIC DISTORTION THD (%)
OUTPUT POWER POUT (W) / CH

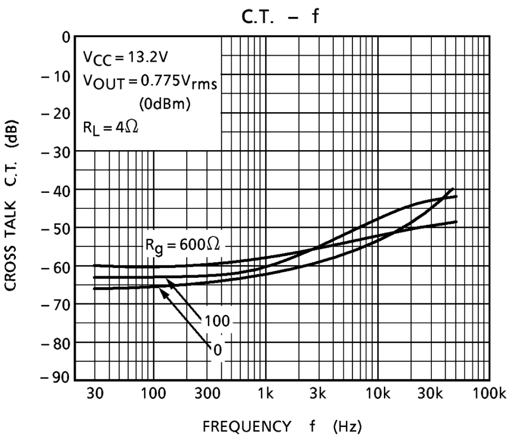

THD – POUT (2)
f = 1kHz
RL = 4Ω
VCC = 10V
13.2
14.4
18
TOTAL HARMONIC DISTORTION THD (%)
OUTPUT POWER POUT (W) / CH

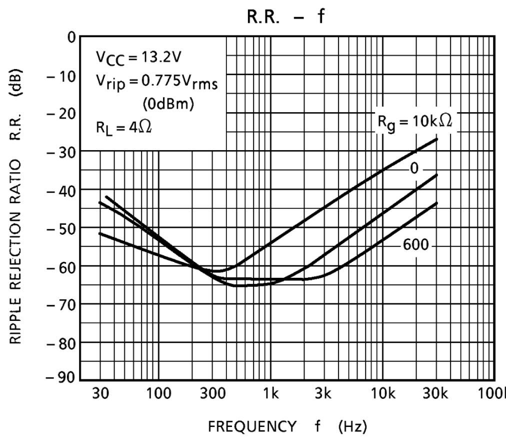

THD – POUT (3)
VCC = 13.2V
RL = 2Ω
f = 10kHz
100Hz
1kHz
TOTAL HARMONIC DISTORTION THD (%)
OUTPUT POWER POUT (W) / CH

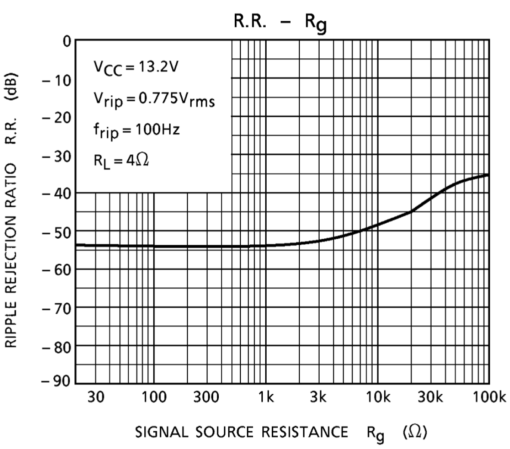

THD – POUT (4)
f = 1kHz
RL = 2Ω
VCC = 10V
13.2
18
14.4
TOTAL HARMONIC DISTORTION THD (%)
OUTPUT POWER POUT (W) / CH

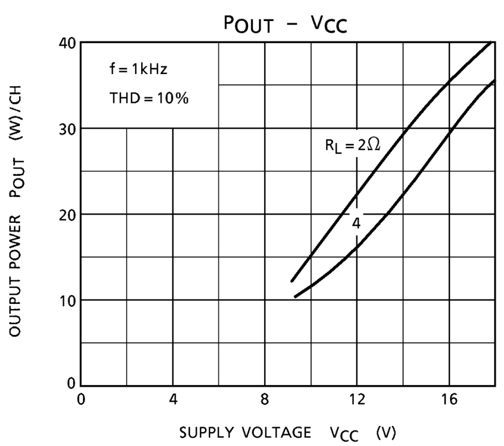

THD – f
VCC = 13.2V
POUT = 1W
RL = 4Ω
TOTAL HARMONIC DISTORTION THD (%)
FREQUENCY f (Hz)

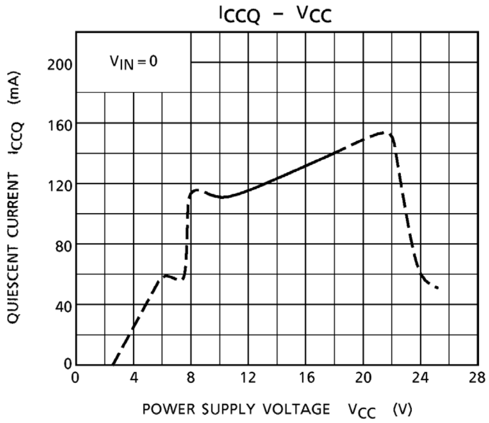

VNO – Rg
VCC = 13.2V
BW = 20Hz~20kHz
RL = 4Ω
GV = 50dB
40
OUTPUT NOISE VOLTAGE VNO (mVrms)
SIGNAL SOURCE RESISTANCE Rg (Ω)

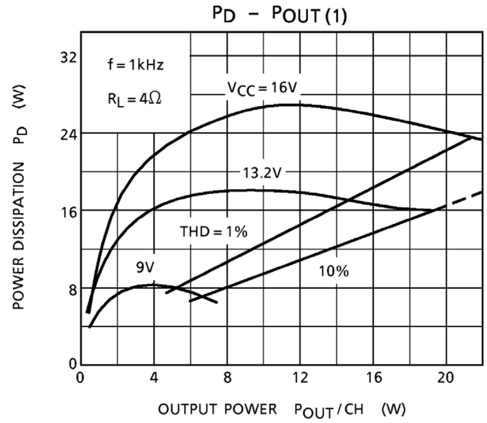

C.T. – f
VCC = 13.2V
VOUT = 0.775Vrms
(0dBm)
RL = 4Ω
Rg = 600Ω
100
0
CROSS TALK C.T. (dB)
FREQUENCY f (Hz)

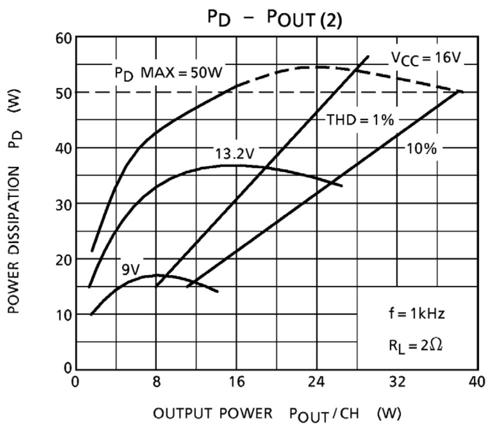

R.R. – f
VCC = 13.2V
Vrip = 0.775Vrms
(0dBm)
RL = 4Ω
Rg = 10kΩ
0
600
RIPPLE REJECTION RATIO R.R. (dB)
FREQUENCY f (Hz)

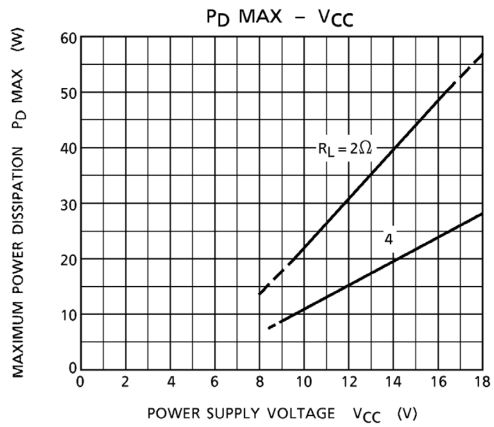

R.R. – Rg
VCC = 13.2V
Vrip = 0.775Vrms
frip = 100Hz
RL = 4Ω
RIPPLE REJECTION RATIO R.R. (dB)
SIGNAL SOURCE RESISTANCE Rg (Ω)

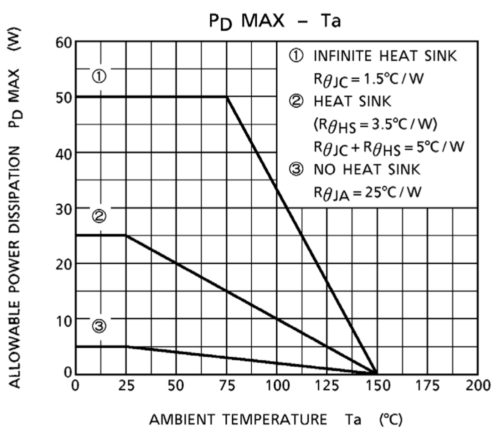

POUT – VCC
f = 1kHz
THD = 10%
RL = 2Ω
4
OUTPUT POWER POUT (W)/CH
SUPPLY VOLTAGE VCC (V)


ICCQ – VCC
VIN = 0
QUIESCENT CURRENT ICCQ (mA)
POWER SUPPLY VOLTAGE VCC (V)


PD – POUT (1)
f = 1kHz
RL = 4Ω
VCC = 16V
13.2V
9V
THD = 1%
10%
POWER DISSIPATION PD (W)
OUTPUT POWER POUT / CH (W)

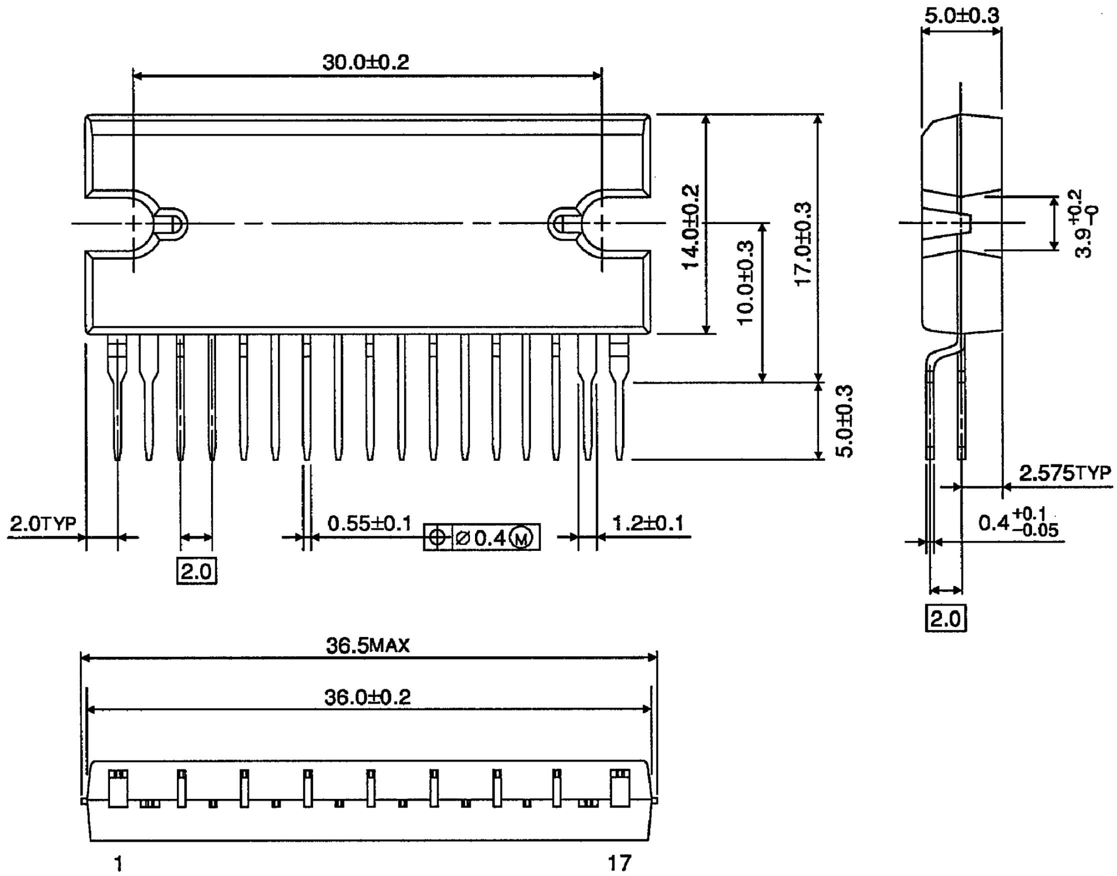

PD – POUT (2)
PD MAX = 50W
VCC = 16V
THD = 1%
10%
13.2V
9V
f = 1kHz
RL = 2Ω
POWER DISSIPATION PD (W)
OUTPUT POWER POUT / CH (W)


PD MAX – VCC
RL = 2Ω
4
MAXIMUM POWER DISSIPATION PD MAX (W)
POWER SUPPLY VOLTAGE VCC (V)


PD MAX – Ta
① INFINITE HEAT SINK
RθJC = 1.5°C / W
② HEAT SINK
(RθHS = 3.5°C / W)
RθJC + RθHS = 5°C / W
③ NO HEAT SINK
RθJA = 25°C / W
ALLOWABLE POWER DISSIPATION PD MAX (W)
AMBIENT TEMPERATURE Ta (°C)

Package Dimensions

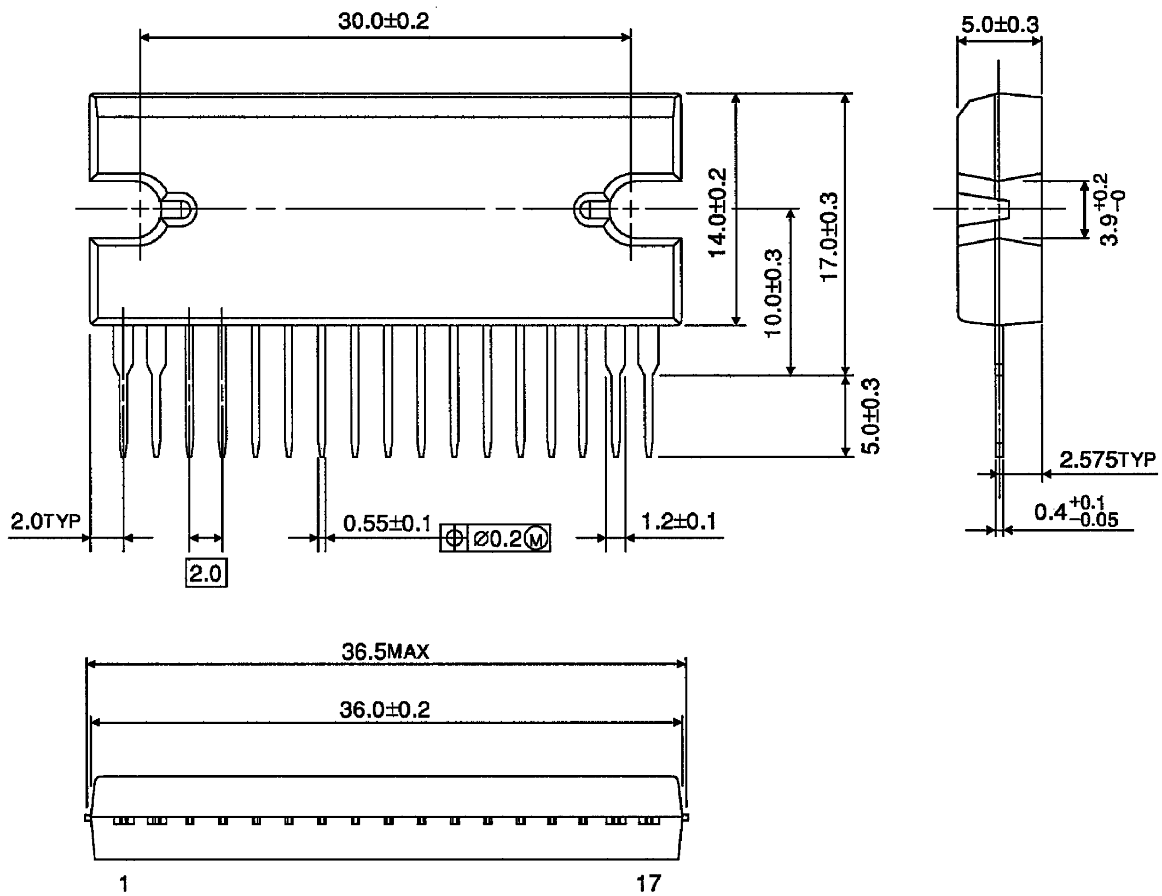
HZIP17-P-2.00 Unit : mm



Weight : 9.8g (typ.)

Package Dimensions

HSIP17-P-2.00 Unit : mm



Weight : 9.8g (typ.)

About solderability, following conditions were confirmed

- Solderability

(1) Use of Sn-63Pb solder Bath
- · solder bath temperature = 230°C
- · dipping time = 5 seconds
- · the number of times = once
- · use of R-type flux

(2) Use of Sn-3.0Ag-0.5Cu solder Bath
- · solder bath temperature = 245°C
- · dipping time = 5 seconds
- · the number of times = once
- · use of R-type flux