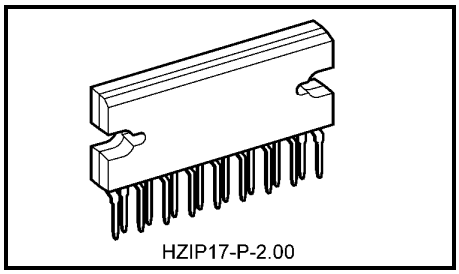
TOSHIBA Bipolar Linear Integrated Circuit Silicon Monolithic

TA8220HQ

30W BTL × 2ch Audio Power Amplifier

The thermal resistance θj−T of TA8220HQ package designed for low thermal resistance, has 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 output short detection circuit, output clip detection and various kind of protection.



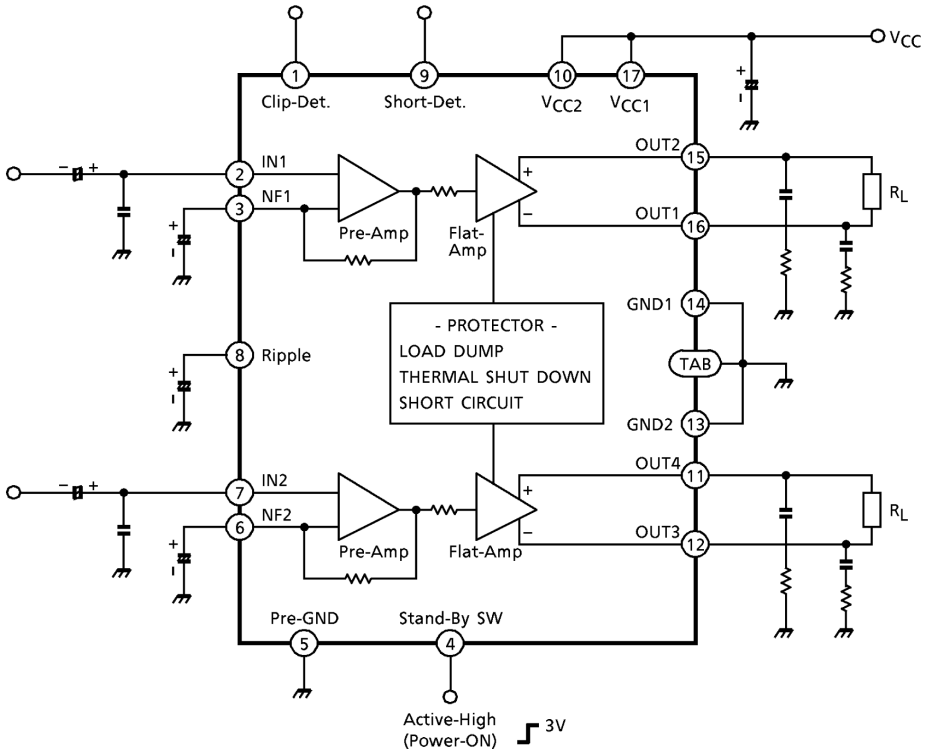
Weight: 9.8g (typ.)

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 (4)pin set at low, power is turned off.): I_{SB} = 1μA (typ.)
- Built−in output short detection circuit ((9)pin: Open collector)
- Built−in output clip detection circuit ((1)pin: Open collector)
- 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} = 9~18V

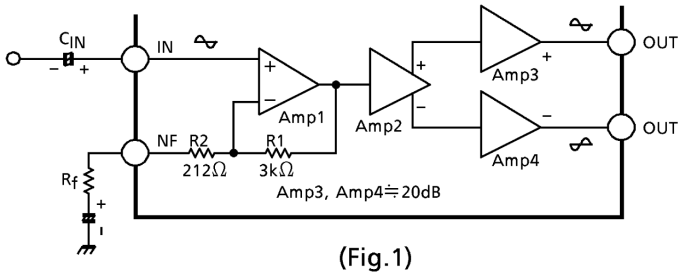
Block Diagram

TA8220HQ (G_V = 50dB)



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

1. Voltage gain adjustment



(Fig.1)

Amp1 : Pre-Amp
Amp2 : Phase Amp
Amp3 : POWER Amp (Flat-Amp)
Amp4 : POWER Amp (Flat-Amp)

This IC has the amplifier constructions as shown Fig.1. The pre–amp (amp1) is provided to the primary stage, and the input voltage is amplified by the flat amps, amp3 and amp4 of each channel through the phase amp (amp2).
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 amp1 is G_{V1}.

$$G_{V1} = 20\log\frac{R_1 + (R_f + R_2)}{R_f + R_2} \quad (dB) \cdots\cdots (1)$$

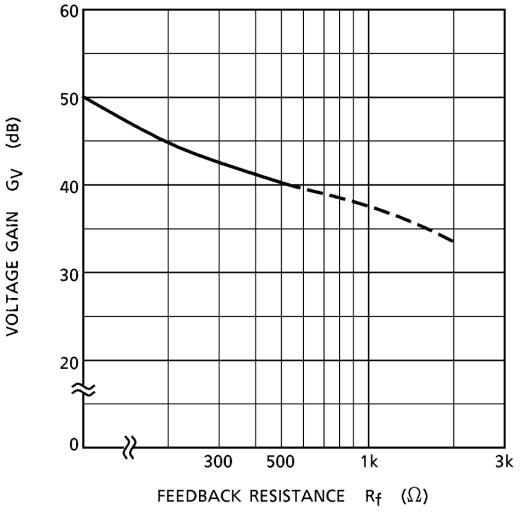
The closed loop voltage gain of power amp, amp3 and amp4 is fixed at $G_{V3} \fallingdotseq G_{V4} = 20dB$.
Therefore, the total closed circuit voltage gain G_V is obtained through BTL connection by the expression below.

$$G_V = G_{V1} + G_{V3} + 6\ (dB) \cdots\cdots (2)$$

For example, when $R_f = 0\Omega$, G_V is obtained by the expressions (1) and (2) as shown below.

$$G_V \fallingdotseq 24 + 20 + 6 = 50dB$$

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.

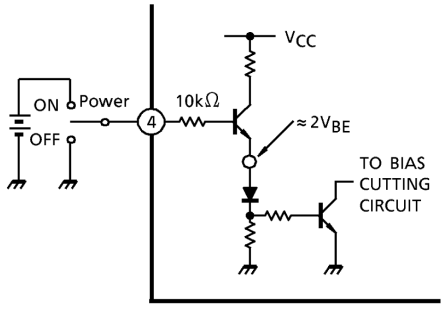


(Fig.2)

2. Stand–by SW function
By means of controlling (4)pin (stand–by terminal) to high and low, the power supply can be set to on and off. The threshold voltage of (4)pin is set at 2.1V ($3V_{BE}$), and the power supply current is about 1μA (typ.) at the stand–by state.

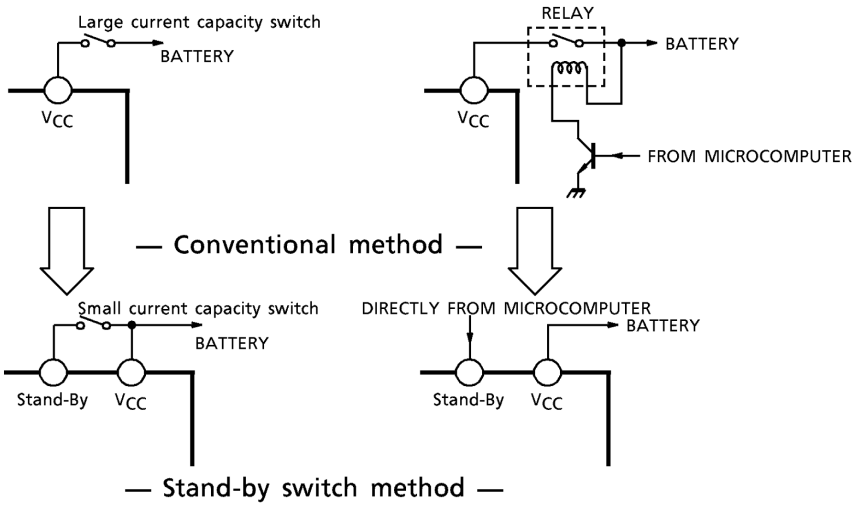
Control voltage of (4)pin: $V_{(SB)}$

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



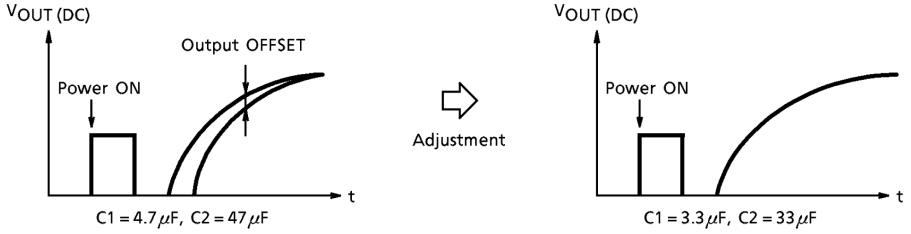
(Fig.3)With ④pin set to high, power is turned ON.

<Adjustage 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.



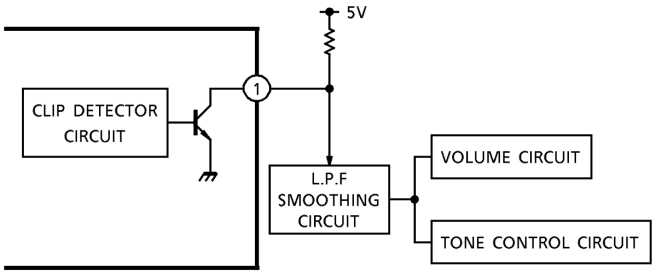
3. Preventive measure against oscillation
   For preventing the oscillation, it is advisable to use C4, the condenser of polyester film having small characteristic fluctuation of the temperature and the frequency.
   The condenser (C6) between input and GND is effective for preventing oscillation which is generated with a feedback signal from a 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 constructed with DC circuit on the pre–amp 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 pre–amp 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. Output clip detection function (pin(1))
   The output clip detection terminal of pin(1) has the open collector output structure on clip as shown in Fig.5. In case that the output waveform is clipping, the clip detection circuit is operated and NPN Tr. is turned on.
   It is possible to improve the tone quality with the current of flowing into pin(1) and with controlling the volume, tone･control circuit through L.P.F smoothing circuit as shown in Fig.5.
   In case of being unused this function, use this IC as open connection on pin(1).
   (Application)

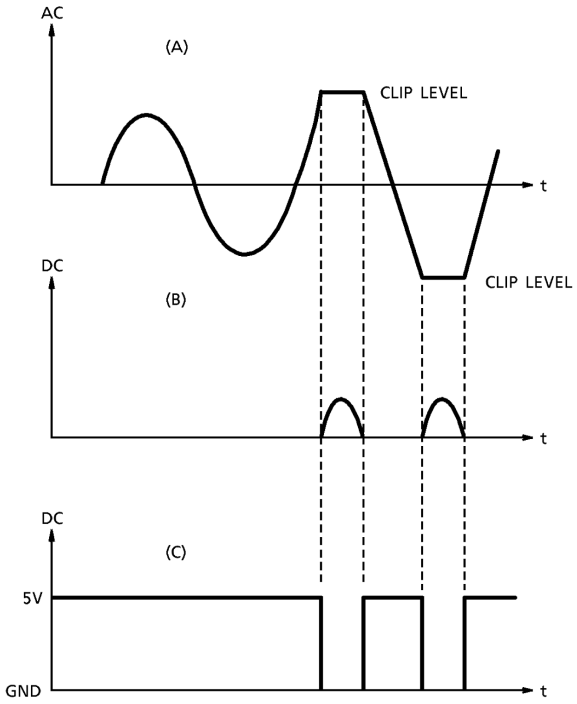


(Fig.5) ①pin : Open collector output (Active low)

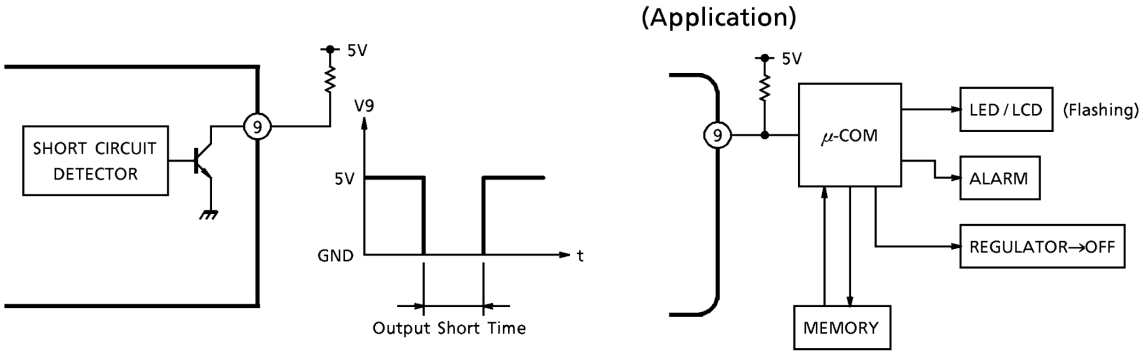
(A) Output

(B) Clip detector circuit

(C) Clip detector terminal
(①pin output)



6. Output to V_{CC}, output to GND detection function (pin(9))
The output short detection terminal of pin(9) has open collector output structure on chip as shown in Fig.6.
In unusual case that output terminal of power amp. is condition of output to V_{CC} or output to GND short, it is possible to protect all the system of apparatus as well as power IC protection.
In case of being unused this function, use this IC as open–connection on pin(9).



⑨pin : Open Collector Output (Active Low)

(Fig.6)

7. External part list and description

Sym–bol	Recommended Value	Feature	Influence		Remarks
			Smaller Than Recommended Value	Larger Than Recommended Value	
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.

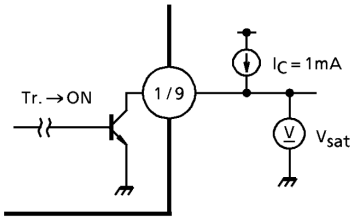
Absolute Maximum Ratings (Ta = 25°C)

Characteristic	Symbol	Rating	Unit
Peak input 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)

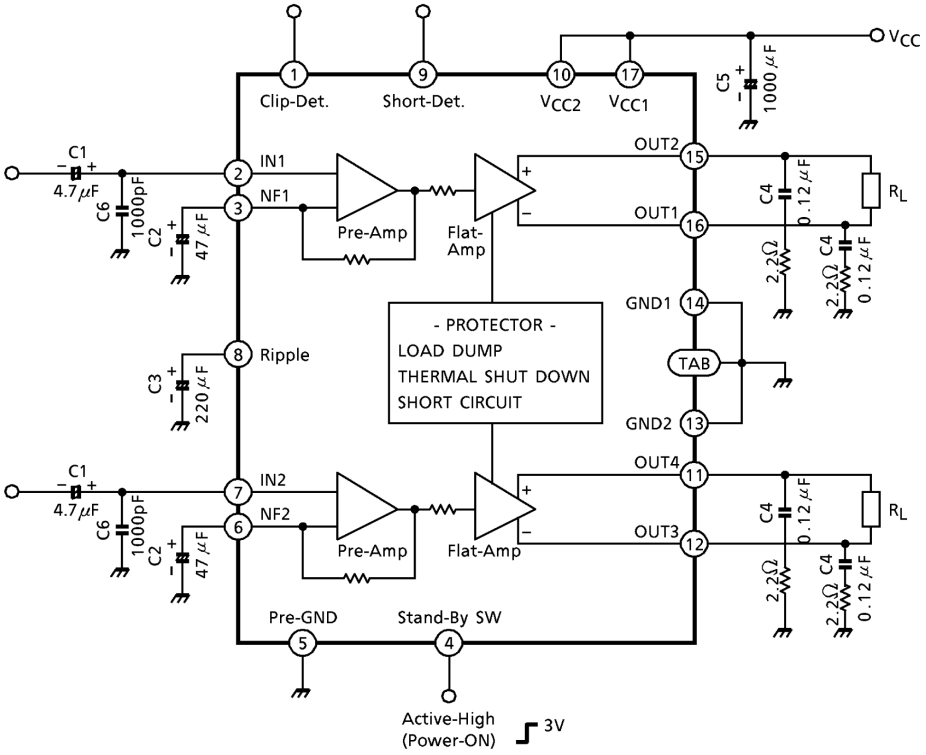
Characteristic	Symbol	Test Cir−cuit	Test Condition	Min.	Typ.	Max.	Unit
Quiescent supply current	I_{CCQ}	—	V_{IN} = 0	—	120	250	mA
Output power	P_{OUT} (1)	—	V_{CC} = 14.4V, R_L = 2Ω, THD = 10%	—	30	—	W
	P_{OUT} (2)	—	R_L = 2Ω, THD = 10%	17	26	—	
	P_{OUT} (3)	—	THD = 10%	16	19	—	
Total harmonic distortion	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.	—	f_{ripple} = 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}	—		—	1	10	μA
Cross talk	C.T.	—	R_g = 600Ω, V_{OUT} = 0.775V_{rms} (0dBm)	—	60	—	dB
(4)pin control voltage	V_{SB}	—	Stand−by→off (power→on)	2.5	—	V_{CC}	V
(1)pin (clip DET) saturation voltage	$V_{sat\ (1)}$	—	I_C = 1mA	—	100	—	mV
(9)pin (short DET) saturation voltage	$V_{sat\ (9)}$	—	I_C = 1mA	—	100	—	mV

$V_{sat\ (1)}$, $V_{sat\ (9)}$ Test Circuit

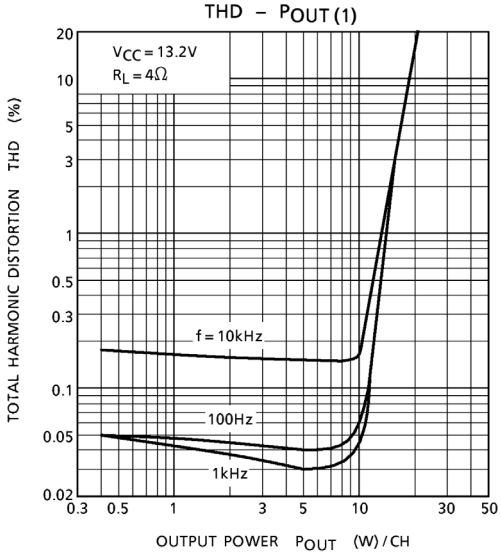


Test Circuit

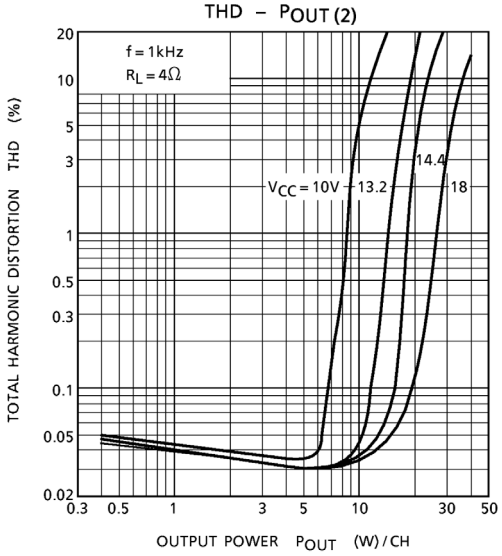
TA8220HQ (G_V = 50dB)



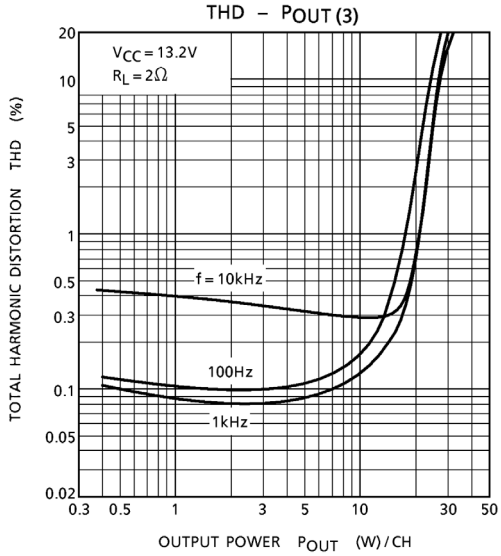
THD – P_{OUT} (1)



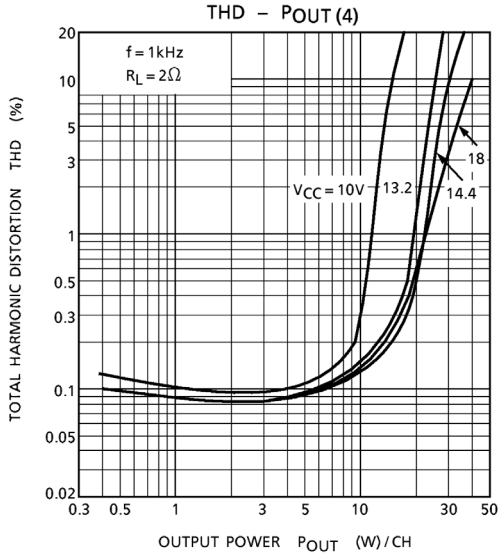
THD – P_{OUT} (2)



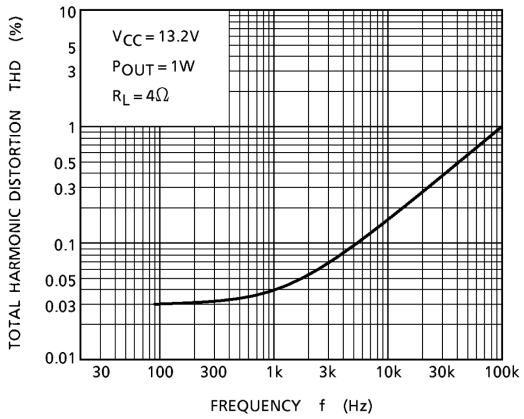
THD – P_{OUT} (3)



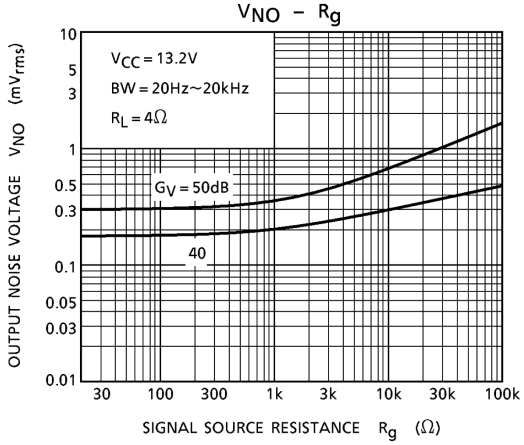
THD – P_{OUT} (4)



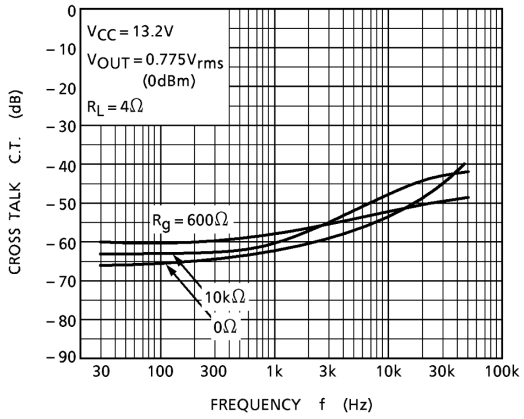
THD – f



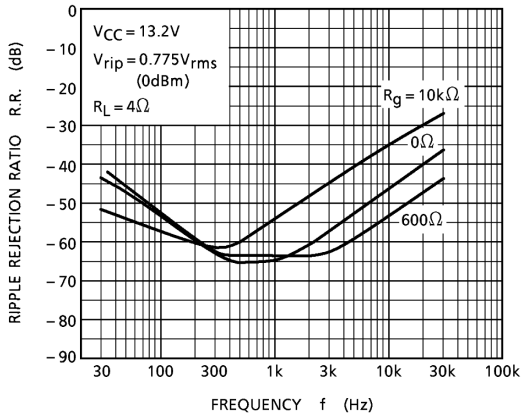
V_{NO} – R_g



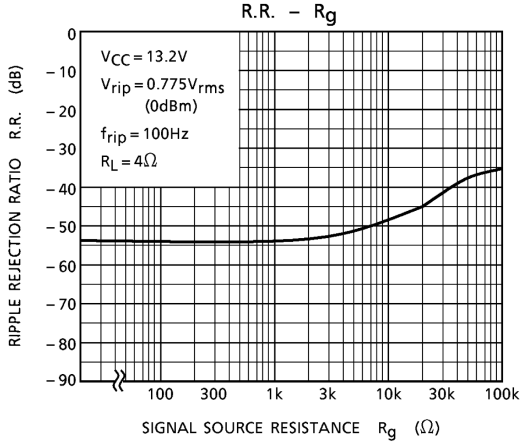
C.T. – f



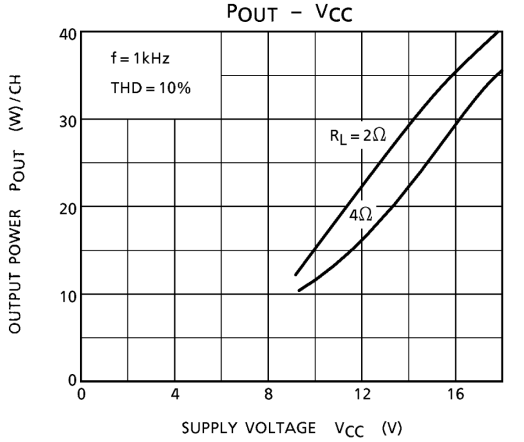
R.R. – f



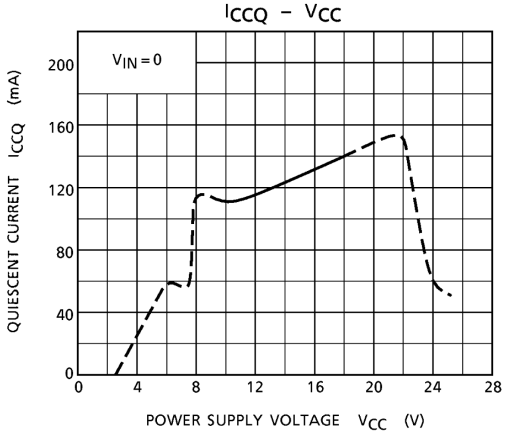
R.R. – R_g



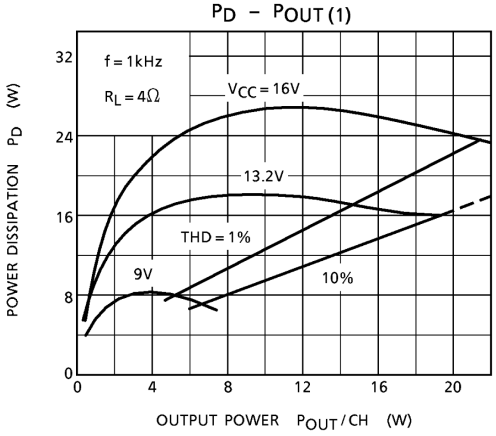
P_{OUT} – V_{CC}



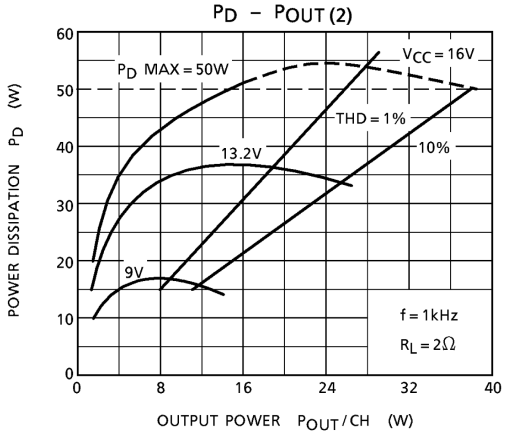
I_{CCQ} – V_{CC}



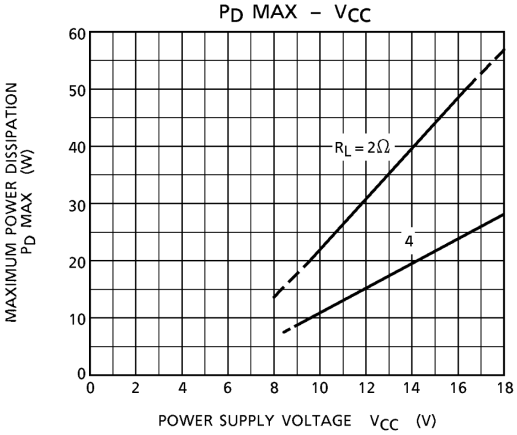
P_D – P_{OUT} (1)



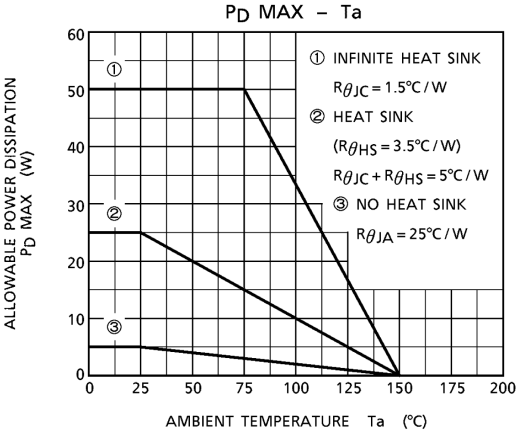
P_D – P_{OUT} (2)



P_D MAX – V_{CC}

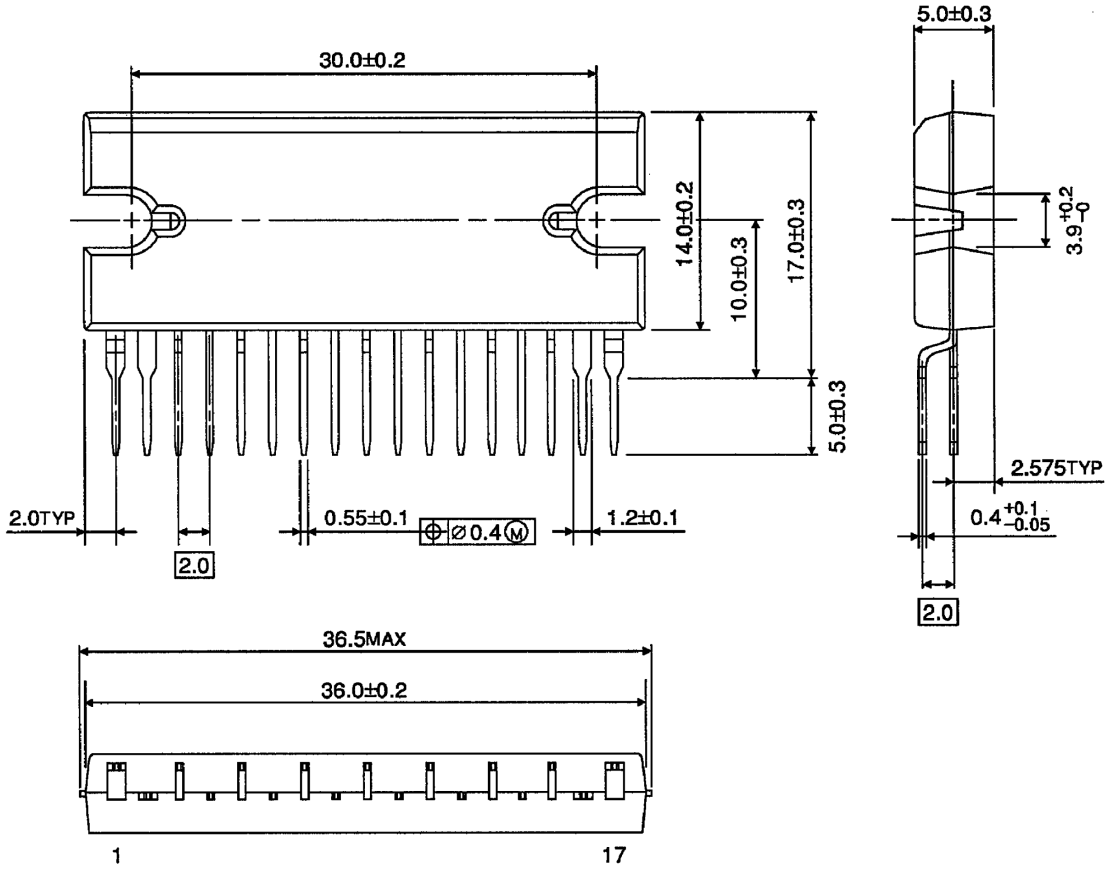


P_D MAX – Ta



Package Dimensions

HZIP17-P-2.00



Weight: 9.8g (typ.)

- Use an appropriate power supply fuse to ensure that a large current does not continuously flow in case of over current and/or IC failure. The IC will fully break down when used under conditions that exceed its absolute maximum ratings, when the wiring is routed improperly or when an abnormal pulse noise occurs from the wiring or load, causing a large current to continuously flow and the breakdown can lead smoke or ignition. To minimize the effects of the flow of a large current in case of breakdown, appropriate settings, such as fuse capacity, fusing time and insertion circuit location, are required.

- If your design includes an inductive load such as a motor coil, incorporate a protection circuit into the design to prevent device malfunction or breakdown caused by the current resulting from the inrush current at power ON or the negative current resulting from the back electromotive force at power OFF. For details on how to connect a protection circuit such as a current limiting resistor or back electromotive force adsorption diode, refer to individual IC datasheets or the IC databook. IC breakdown may cause injury, smoke or ignition.

- Use a stable power supply with ICs with built-in protection functions. If the power supply is unstable, the protection function may not operate, causing IC breakdown. IC breakdown may cause injury, smoke or ignition.

- Carefully select external components (such as inputs and negative feedback capacitors) and load components (such as speakers), for example, power amp and regulator. If there is a large amount of leakage current such as input or negative feedback condenser, the IC output DC voltage will increase. If this output voltage is connected to a speaker with low input withstand voltage, overcurrent or IC failure can cause smoke or ignition. (The over current can cause smoke or ignition from the IC itself.) In particular, please pay attention when using a Bridge Tied Load (BTL) connection type IC that inputs output DC voltage to a speaker directly.

- Over current Protection Circuit
  Over current protection circuits (referred to as current limiter circuits) do not necessarily protect ICs under all circumstances. If the Over current protection circuits operate against the over current, clear the over current status immediately. Depending on the method of use and usage conditions, such as exceeding absolute maximum ratings can cause the over current protection circuit to not operate properly or IC breakdown before operation. In addition, depending on the method of use and usage conditions, if over current continues to flow for a long time after operation, the IC may generate heat resulting in breakdown.

- Thermal Shutdown Circuit
  Thermal shutdown circuits do not necessarily protect ICs under all circumstances. If the Thermal shutdown circuits operate against the over temperature, clear the heat generation status immediately. Depending on the method of use and usage conditions, such as exceeding absolute maximum ratings can cause the thermal shutdown circuit to not operate properly or IC breakdown before operation.

- Heat Radiation Design
  When using an IC with large current flow such as power amp, regulator or driver, please design the device so that heat is appropriately radiated, not to exceed the specified junction temperature (Tj) at any time and condition. These ICs generate heat even during normal use. An inadequate IC heat radiation design can lead to decrease in IC life, deterioration of IC characteristics or IC breakdown. In addition, please design the device taking into considerate the effect of IC heat radiation with peripheral components.

- Installation to Heat Sink
  Please install the power IC to the heat sink not to apply excessive mechanical stress to the IC. Excessive mechanical stress can lead to package cracks, resulting in a reduction in reliability or breakdown of internal IC chip. In addition, depending on the IC, the use of silicon rubber may be prohibited. Check whether the use of silicon rubber is prohibited for the IC you intend to use, or not. For details of power IC heat radiation design and heat sink installation, refer to individual technical datasheets or IC databooks.

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- This product generates heat during normal operation. However, substandard performance or malfunction may cause the product and its peripherals to reach abnormally high temperatures.
  The product is often the final stage (the external output stage) of a circuit. Substandard performance or malfunction of the destination device to which the circuit supplies output may cause damage to the circuit or to the product. 030619_R

About solderability, following conditions were confirmed

- Solderability

  (1) Use of Sn-37Pb 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