

3V dual preamplifier

BA3304F

The BA3304F is a monolithic, dual-preamplifier IC designed for 3V applications. It been designed especially for low-voltage operation.

The preamplifiers can be directly coupled to the head to minimize the "pop" noise at power on. When combined with the Rohm BA5204, it is a simple matter to design a high-performance circuit for cassette players.

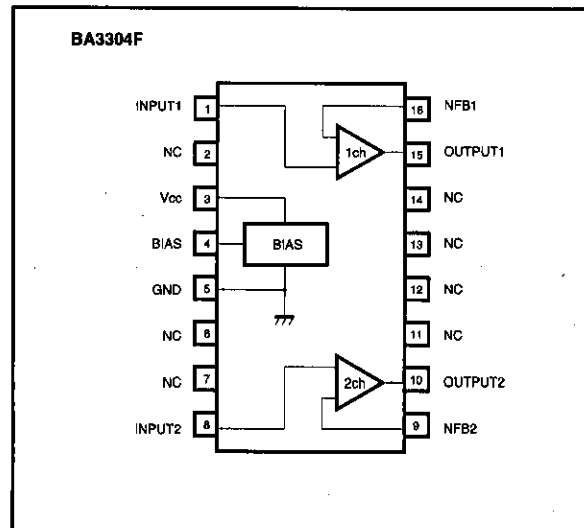
●Applications

3V headphone stereos, 3V micro-cassette players and low-voltage stereo equipment.

●Features

- 1) Low noise ($V_{NIN} = 1.2 \mu V_{rms}$).
- 2) Input coupling capacitors not required.
- 3) No input coupling capacitors means high bass stability.
- 4) Good channel balance.
- 5) Built-in bias circuit minimizes "pop" noise.
- 6) Emitter-follower output for low output impedance.
- 7) Good low voltage characteristics (operation possible from 1.2V).

●Block diagram



Preamplifiers

Low-frequency amplifiers

● Absolute maximum ratings (Ta = 25°C)

Parameter	Symbol	Limits	Unit
Supply voltage	V _{CC}	4.5	V
Power dissipation	P _d	500 *	mW
Operating temperature	T _{opr}	-25~75	°C
Storage temperature	T _{stg}	-55~125	°C

* When mounted on a 50mm x 50mm x 1.6mm glass-epoxy PCB, reduced by 5.0mW for each increase in Ta of 1°C over 25°C.

● Internal circuit diagram

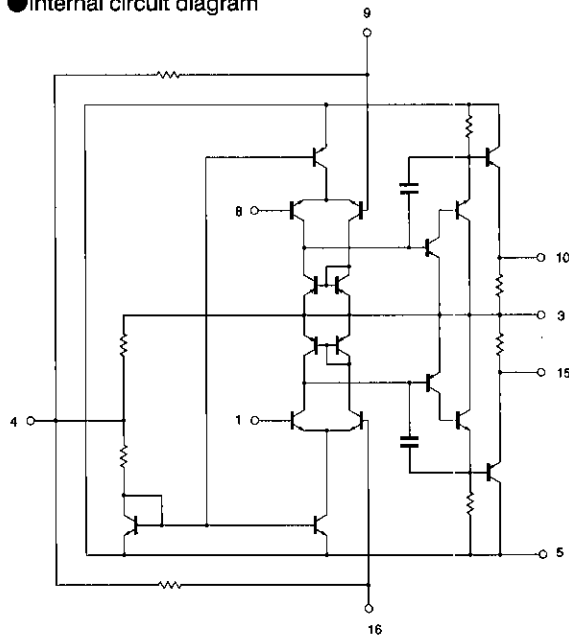


Fig. 1

● Description of circuit (see Fig. 1)

As shown in the equivalent circuit for the BA3304 in Fig. 1, the first stage is a differential amplifier. This gives good stability with respect to temperature and supply voltage variation, and improves resistance to earth and power supply noise.

The second stage uses Darlington pairs to increase the input impedance and the gain of the first stage. The output is an emitter follower which suppresses deterioration of the linearity due to the influence of the equalizer terminal, and prevents drop in maximum output.

● Electrical characteristics (unless otherwise specified Ta = 25°C, V_{CC} = 3V, f = 1kHz and R_L = 10 Ω)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions	Measurement Circuit
Quiescent current	I _Q	0.6	1.5	2.8	mA	V _{IN} =0V _{rms}	Fig.2
Open-loop voltage gain	G _{VO}	68	80	—	dB	V _{OUT} =-10dBm, f=1kHz	Fig.2
Input conversion noise voltage	V _{NIN}	—	1.2	2.2	μV _{rms}	V _{IN} =0V _{rms} , R _g =2.2kΩ BPF (20~20kHz)	Fig.2
Maximum output voltage	V _{OM}	300	560	—	mV _{rms}	THD=1%, f=1kHz	Fig.2
Channel separation	CS	—	-65	-55	dB	Other channel R _g = 2.2kΩ.R f=1kHz	Fig.2
Input bias current	I _b	—	180	400	nA	V _{IN} =0V _{rms}	Fig.2
Total harmonic distortion	THD	—	0.05	0.2	%	V _{OUT} =0.3V _{rms} , f=1kHz	Fig.2

● Measurement circuit

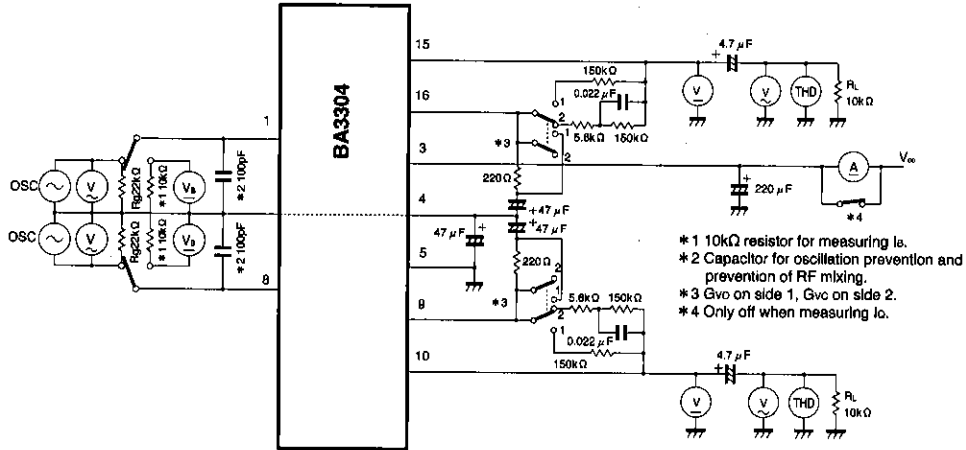


Fig. 2

● Application example (Fig. 3)

C₁ and C₂ : Capacitors for prevention of oscillation and RF mixing

The recommended value is 100pF. If the value of the capacitors is too small, oscillation and RF noise due to strong RF signals can degrade circuit performance. If the value of the capacitors is too large, the audio frequency characteristics will deteriorate.

C₃ : Filter capacitor

The recommended value is 47 μF. The startup time after power is applied is related to the value of this capacitor. If the value of the capacitors is too small, transient noise when power is applied will be large.

C₄ and C₅ : Bypass capacitors

The recommended value is 47 μF. The time constant of the circuits formed by these capacitors and the resistors R₁ and R₂ determines the bass cutoff frequency.

R₁ to R₆, and C₇ and C₈ : equalizer terminal (NAB)

These components set the time constant for normal tape (120 μ S), and the tape speed to 4.75cm/s. The gain is 33dB at 1kHz.

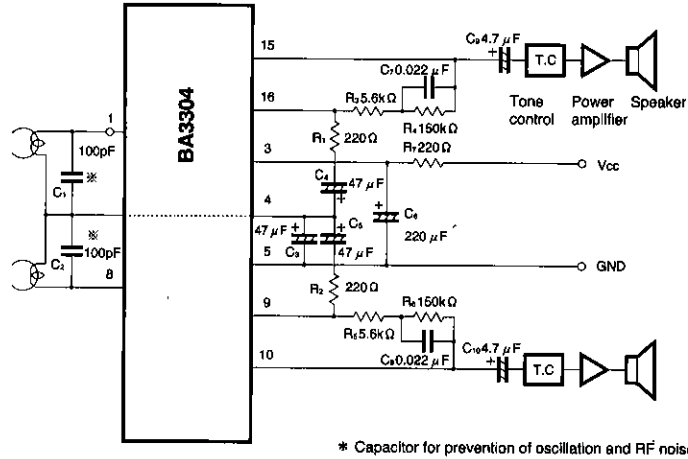


Fig. 3

Preamplifiers

Low-frequency amplifiers

● Electrical characteristics curves

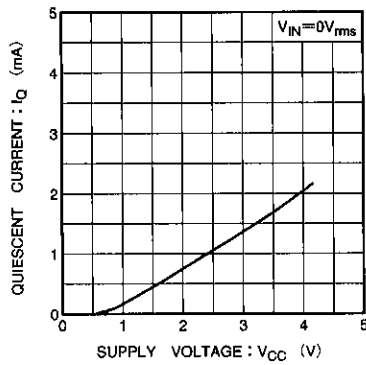


Fig. 4 Quiescent current vs. supply voltage

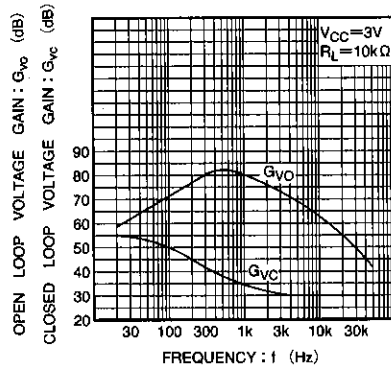


Fig. 5 Voltage gain vs. frequency

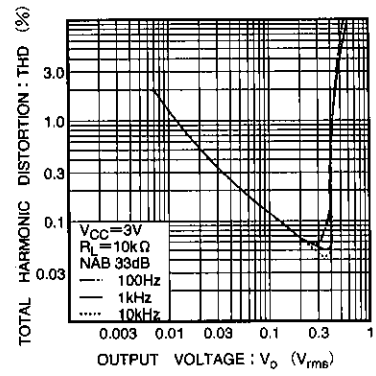


Fig. 6 Total harmonic distortion vs. output voltage

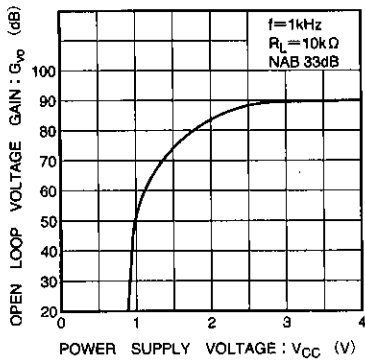


Fig. 7 Open-loop voltage gain vs. supply voltage

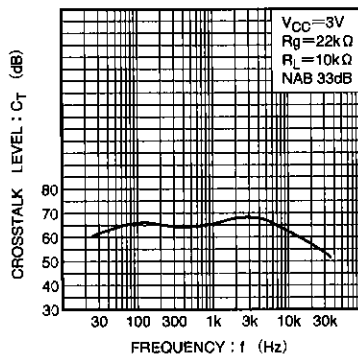


Fig. 8 Crosstalk vs. frequency

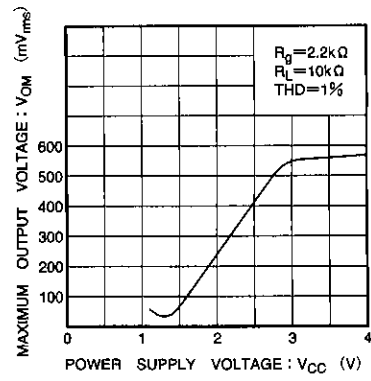


Fig. 9 Maximum output voltage vs. supply voltage

● Operation notes

(1) Input-side virtual ground

If coupling capacitors are used to connect the head with the preamplifier input, the capacitor charging current flows in the head and can magnetize it. To prevent this, a virtual ground is used on the input side, and coupling capacitors are not required even with a single-rail supply.

This is the bias pin input and the virtual ground point for the negative feedback, and the bias for the input transistor is taken from this terminal. The only DC current that flows in the magnetic head is the base bias current for the input transistor, which is not enough to magnetize the head.

(2) Capacitor for prevention of oscillation and RF mixing

With the BA3304F, a capacitor must be connected between each input pin and the bias pins to prevent oscillation and RF mixing. The recommended value for this capacitor is 100pF. If it is too small, oscillation and RF noise can adversely affect circuit performance. Conversely, if the value of the capacitor is too large, it will affect the audio frequency characteristics. These capacitors can also be used for treble compensation. Determine the value based on the relationship with the magnetic head impedance.

(3) Bypass capacitor

The capacitor connected in series with the gain-setting resistor between the NF pin and the bias pin, is the bypass capacitor. The value of this capacitor determines the bass characteristics

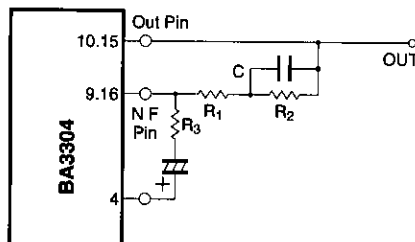


Fig. 10

(4) Playback equalizer (NBA)

The playback equalizer characteristics are determined by the RC circuit connected between the output pin and the NF pin. For the circuit shown in Fig. 10, with a closed-loop gain of G_{VC} (dB) at a frequency of 1kHz, the value of the circuit components is given by the following equations :

$$R_2 = 15.6 \times R_3 \times 10^{G_{VC}/20} \quad (\Omega)$$

$$R_1 = \frac{2}{53} \times R_2 \quad (\Omega)$$

$$C = \frac{3180 \times 10^{-6}}{R_2} \quad (F)$$

The recommended value for R_3 is about 100 Ω . If R_3 is too large, the voltage gain will not match the calculated value.

(5) Capacitive loads

The BA3304F has an emitter-follower output, so oscillation is apt to occur if the load is capacitive (if the capacitance of the load exceeds 150pF with $V_{CC} = 3V$, oscillation will occur). Oscillation is apt to occur if the closed-loop gain (G_{VC}) is lower than 30dB at $f = 1kHz$. Caution is especially required with long lengths of thin shielded wire. If use of a large capacitive load cannot be avoided, connect a resistor of a few hundred ohms in series with the load.

(6) Input/output interference

Performance degradation due to input/output interference is related to the amplifier gain, the amount of feedback from the output to the input, and amplifier phase rotation. Care is required to avoid component layouts that will cause input/output interference when high gain is used. With regard to component layout, we recommend that you separate the virtual earth for the input and output components, and have one earth at the bias pin.

(7) Assembly precautions

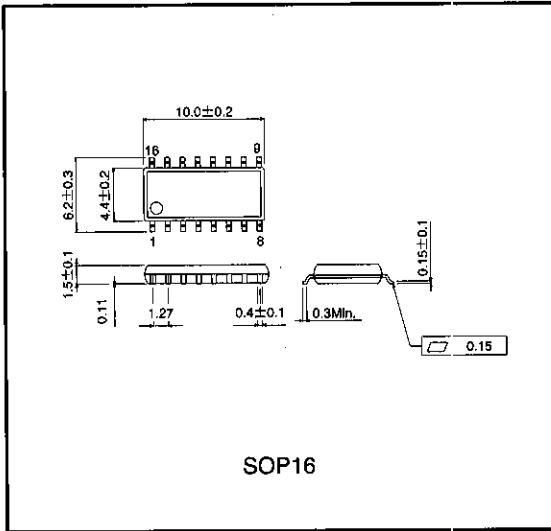
a) Power supply

To avoid possible destruction of the IC, before connecting the power supply pins to the PCB, ensure that there are no shorts due to solder bridges, and take care to ensure that the polarity is correct.

b) Static

Static electricity that accumulates on the clothing of operators and on belt conveyors can range from thousands to tens of thousands of volts. To prevent damage to components due to static discharge, ensure that all operators and conveyor belts are earthed.

●External dimensions (Unit: mm)



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