

Pre / power amplifier and motor governor for 3V headphone stereos

BA3528AFP / BA3529AFP

The BA3528AFP and AB3529AFP have been developed for headphone stereos. They run off a 3V power supply, and include dual pre- and power amplifiers, and a motor governor.

The preamplifiers are direct-coupled, and the power amplifiers use a fixed-gain NF circuit. An on-chip V_{REF} amplifier makes output coupling capacitors unnecessary, and the motor governor uses a bridge ratio system to minimize the external parts count and make reliable and compact designs possible.

●Applications

3V portable stereo equipment

●Features

- 1) All the functions required for headphone stereo units on a single chip.
- 2) Preamplifier includes a mute amplifier.
- 3) Direct-coupled preamplifier.
- 4) No output coupling capacitors required for the power amplifiers.
- 5) Power amplifiers do not require oscillation prevention measures.
- 6) Power amplifier gain allows use of noise reduction (BA3529AFP).

●Absolute maximum ratings ($T_a = 25^\circ\text{C}$)

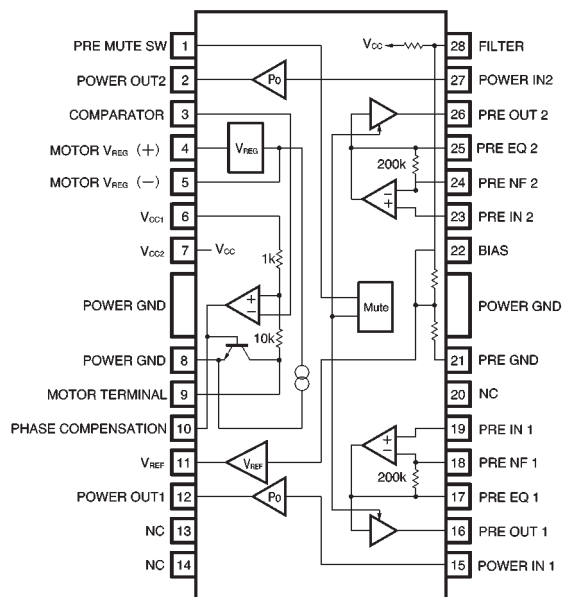
| Parameter | Symbol | Limits | Unit |
|-----------------------|-----------|-----------------|------------------|
| Power supply voltage | V_{CC} | 6 | V |
| Power dissipation | P_d | 1.7* | W |
| Operating temperature | T_{opr} | $-25 \sim +75$ | $^\circ\text{C}$ |
| Storage temperature | T_{stg} | $-55 \sim +150$ | $^\circ\text{C}$ |

* Reduced by 13.6mW for each increase in T_a of 1°C over 25°C
(when mounted on a 90mm \times 50mm \times 1.6mm glass epoxy board).

●Recommended operating conditions ($T_a = 25^\circ\text{C}$)

| Parameter | Symbol | Min. | Typ. | Max. | Unit |
|----------------------|----------|------|------|------|------|
| Power supply voltage | V_{CC} | 1.8 | 3.0 | 6.0 | V |

● Block diagram



●Electrical characteristics (unless otherwise noted, $T_a = 25^\circ\text{C}$, $V_{CC} = 3\text{V}$, and $f = 1\text{kHz}$)

BA3528AFP

| Parameter | Symbol | Min. | Typ. | Max. | Unit | Conditions |
|--------------------------------|---|-------|------|------|--|---|
| Quiescent current | I_Q | — | 11 | 18 | mA | $V_{IN}=0V_{rms}$ |
| Channel separation | CS L-R | 30 | 40 | — | dB | $R_g=2.2k\Omega$, $R_L=32\Omega$ |
| (Preamplifier) | | | | | $R_L=10k\Omega$ | |
| Open loop voltage gain | G_{VO} | 72 | 80 | — | dB | $V_O=200mV_{rms}$ |
| Closed loop voltage gain | G_{VC1} | 33 | 36 | 39 | dB | $V_O=100mV_{rms}$ |
| Maximum output voltage | V_{OM} | 350 | 500 | — | mV _{rms} | THD=1% |
| Total harmonic distortion | THD1 | — | 0.03 | 0.2 | % | $V_O=200mV_{rms}$ |
| Input conversion noise voltage | V_{NIN} | — | 1.0 | 1.8 | μV_{rms} | $R_g=2.2k\Omega$, BPF=20~20kHz |
| Ripple rejection ratio | RR1 | 43 | 53 | — | dB | $f_{RR}=100\text{Hz}$, $V_{RR}=-20\text{dBm}$ |
| Input bias current | I_B | — | 365 | 850 | nA | $V_{IN}=0V_{rms}$ |
| Mute level | MUTE | — | 80 | — | dB | |
| (Power amplifier) | | | | | $R_L=32\Omega$ (excluding P_{OUT1}) | |
| Rated output 1 | P_{OUT1} | 25 | 34 | — | mW/ch | $R_L=16\Omega$, THD=10% |
| Rated output 2 | P_{OUT2} | 14.5 | 20 | — | mW/ch | $R_L=32\Omega$, THD=10% |
| Total harmonic distortion | THD 2 | — | 0.2 | 1.0 | % | $P_O=1mW$ |
| Output noise voltage | V_{NO} | — | 65 | 100 | μV_{rms} | BPF=20~20kHz |
| Ripple rejection ratio | RR2 | 53 | 61 | — | dB | $f_{RR}=100\text{Hz}$, $V_{RR}=-20\text{dBm}$ |
| Closed loop voltage gain | G_{VC2} | 33 | 36 | 39 | dB | $V_O=300mV_{rms}$ |
| Input resistance | R_{IN} | 13 | 18 | 23 | k Ω | |
| (Motor controller) | | | | | | |
| Quiescent current | I_Q | — | 2 | 3.5 | mA | |
| Reference voltage | V_{REG} | 1.16 | 1.23 | 1.31 | V | Voltage between pins 4 and 5 ($R_{s4}\geq 20k\Omega$) |
| Saturation voltage | V_{SAT} | — | 0.2 | 0.6 | V | $V_{CC}=1.8\text{V}$, $R_a=4.7\Omega$ |
| Voltage characteristic 1 | $\frac{\Delta V_{REG}}{V_{REG}} / V_{CC}$ | -1.25 | 0.1 | 1.25 | % / V | $V_{CC}=1.8\text{V}\sim 6\text{V}$ |
| Voltage characteristic 2 | $\frac{\Delta V_a}{V_a} / V_{CC}$ | -1.2 | 0.1 | 1.2 | % / V | $V_{CC}=1.8\text{V}\sim 6\text{V}$ |
| Current characteristic | $\frac{\Delta V_{REG}}{V_{REG}} / I_Q$ | -0.2 | 0.01 | 0.2 | % / A | $I_Q=1\text{mA}\sim 20\text{mA}$ |
| Temperature characteristic | $\frac{\Delta V_{REG}}{V_{REG}} / T_a$ | — | 0.01 | — | % / $^\circ\text{C}$ | $T_a=-25\sim +75^\circ\text{C}$ |

BA3529AFP

| Parameter | Symbol | Min. | Typ. | Max. | Unit | Conditions |
|--------------------------------|---|-------|------|------|--|--|
| Quiescent current | I_Q | — | 11 | 18 | mA | $V_{IN}=0V_{rms}$ |
| Channel separation | CS L-R | 35 | 45 | — | dB | $R_g=2.2k\Omega$, $R_L=32\Omega$ |
| (Preamplifier) | | | | | $R_L=10k\Omega$ | |
| Open loop voltage gain | G_{VO} | 72 | 80 | — | dB | $V_O=200mV_{rms}$ |
| Closed loop voltage gain | G_{VC1} | 33 | 36 | 39 | dB | $V_O=100mV_{rms}$ |
| Maximum output voltage | V_{OM} | 350 | 500 | — | mV _{rms} | THD=1% |
| Total harmonic distortion | THD1 | — | 0.03 | 0.2 | % | $V_O=200mV_{rms}$ |
| Input conversion noise voltage | V_{NIN} | — | 1.0 | 1.8 | μV_{rms} | $R_g=2.2k\Omega$, BPF=20~20kHz |
| Ripple rejection ratio | RR1 | 43 | 53 | — | dB | $f_{RR}=100Hz$, $V_{RR}=-20dBm$ |
| Input bias current | I_B | — | 365 | 850 | nA | $V_{IN}=0V_{rms}$ |
| Mute level | MUTE | — | 80 | — | dB | |
| (Power amplifier) | | | | | $R_L=32\Omega$ (excluding P_{OUT1}) | |
| Rated output 1 | P_{OUT1} | 25 | 34 | — | mW/ch | $R_L=16\Omega$, THD=10% |
| Rated output 2 | P_{OUT2} | 14.5 | 20 | — | mW/ch | $R_L=32\Omega$, THD=10% |
| Total harmonic distortion | THD 2 | — | 0.1 | 0.9 | % | $P_O=1mW$ |
| Output noise voltage | V_{NO} | — | 26 | 50 | μV_{rms} | BPF=20~20kHz |
| Ripple rejection ratio | RR2 | 61 | 69 | — | dB | $f_{RR}=100Hz$, $V_{RR}=-20dBm$ |
| Closed loop voltage gain | G_{VC2} | 25 | 27 | 29 | dB | $V_{IN}=300V_{rms}$ |
| Input resistance | R_{IN} | 13 | 18 | 23 | k Ω | |
| (Motor controller) | | | | | | |
| Quiescent current | I_Q | — | 2 | 3.5 | mA | |
| Reference voltage | V_{REG} | 1.16 | 1.23 | 1.31 | V | Voltage between pins 4 and 5 ($R_{5-4}\geq 20k\Omega$) |
| Saturation voltage | V_{SAT} | — | 0.2 | 0.6 | V | $V_{CC}=1.8V$, $R_a=4.7\Omega$ |
| Voltage characteristic 1 | $\frac{\Delta V_{REG}}{V_{REG}} / V_{CC}$ | -1.25 | 0.1 | 1.25 | % / V | $V_{CC}=1.8V\sim 6V$ |
| Voltage characteristic 2 | $\frac{\Delta V_a}{V_a} / V_{CC}$ | -1.2 | 0.1 | 1.2 | % / V | $V_{CC}=1.8V\sim 6V$ |
| Current characteristic | $\frac{\Delta V_{REG}}{V_{REG}} / I_B$ | -0.2 | 0.01 | 0.2 | % / A | $I_B=1mA\sim 20mA$ |
| Temperature characteristic | $\frac{\Delta V_{REG}}{V_{REG}} / T_a$ | — | 0.01 | — | % / $^{\circ}C$ | $T_a=-25\sim +75^{\circ}C$ |

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● Circuit operation

(1) Preamplifier

In the preamplifier input stage the pin 22 bias is the input and the negative feedback virtual earth, and the bias for the input stage transistor is taken from pin 22 via the tape head to allow direct coupling. Connect a 1000pF capacitor in parallel with the tape head to prevent high-frequency interference (see Fig. 2).

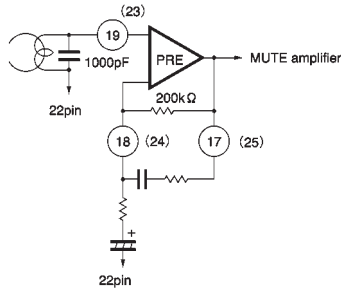


Fig. 2

(2) Mute amplifier

Preamplifier output muting can be switched on and off. The mute is off when the mute switch input (pin 1) is low or open, and on when the mute switch input is high (tied to V_{CC} via a resistor), see Fig. 3.

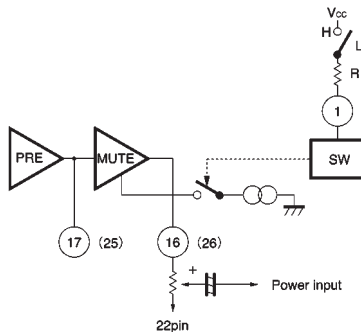


Fig. 3

(3) Equalizer

The preamplifier is based on an NAB120μs NF-type equalizer. It is possible to add a switching function for the equalizer using the mute amplifier. Switching of the equalizer constant is controlled by the voltage on pin 1 (low or high). Note, however, when this is done, preamplifier muting no longer operates (see Fig. 4).

(4) Power amplifier

The power amplifier employs an NF circuit with fixed gain. $G_{VC} = 36\text{dB}$ (BA3528AFP) and $G_{VC} = 27\text{dB}$ (BA3529AFP).

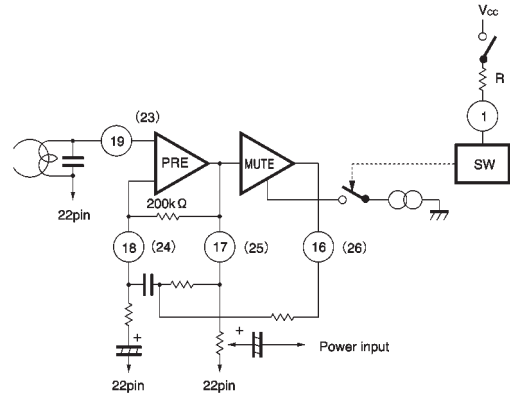


Fig. 4

For the input stage, the pin 22 bias point is the input and the negative feedback virtual earth point, and the first stage transistor bias is taken from pin 22. The built-in V_{REF} amplifier uses the same bias point as its input, and its output voltage is about the same as DC output voltage from the power amplifier. This becomes the virtual earth for the headphones (see Fig. 5).

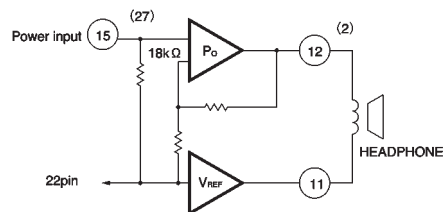


Fig. 5

(5) Motor controller circuit

The motor controller circuit uses a resistance bridge to maintain uniform motor speed regardless of changes in supply voltage, ambient temperature and load torque. Speed control is performed by a comparator and a stable on-chip reference voltage ($V_{REG} = 1.23V$). See Fig. 6.

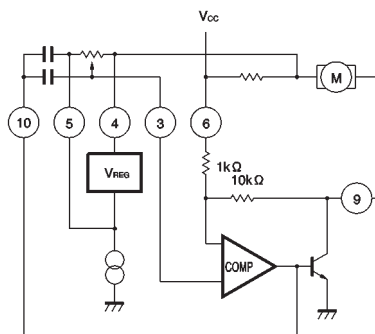


Fig. 6

● Application examples

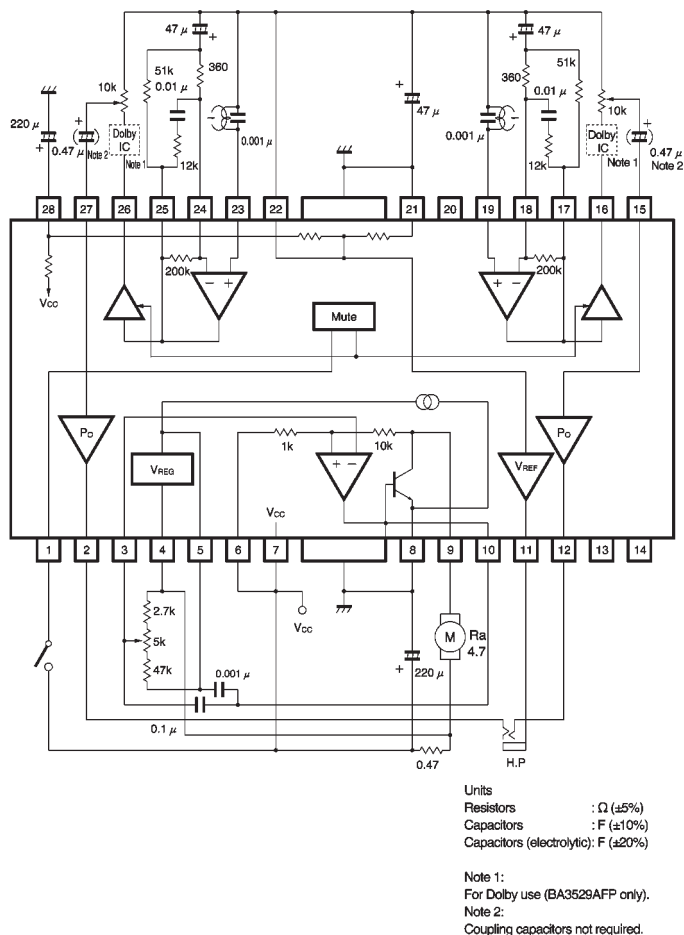
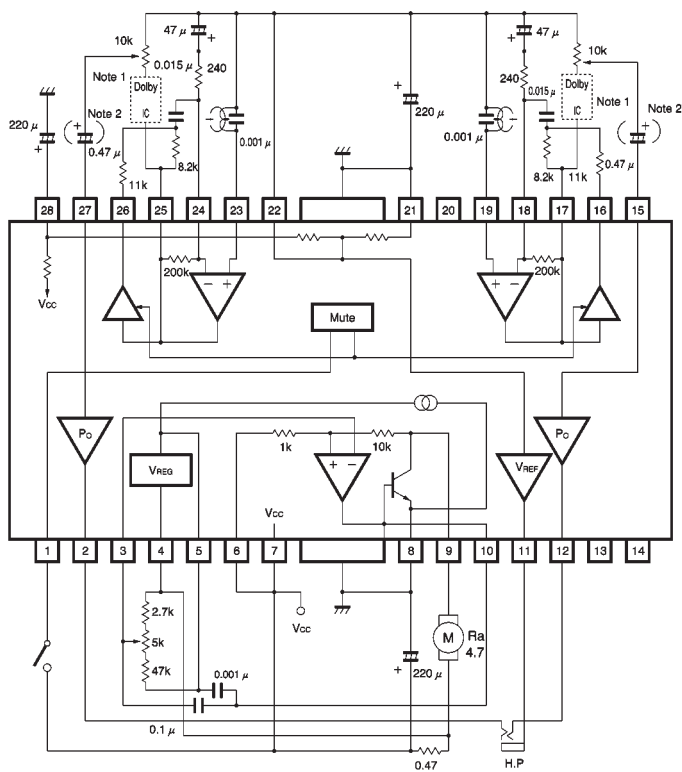


Fig. 7 Headphone stereo with pre-mute



Units
 Resistors : Ω ($\pm 5\%$)
 Capacitors : F ($\pm 10\%$)
 Capacitors (electrolytic): F ($\pm 20\%$)

Note 1:
 For Dolby use (BA3529AFP only).
 Note 2:
 Coupling capacitors not required.

Fig. 8 Headphone stereo metal / normal switch

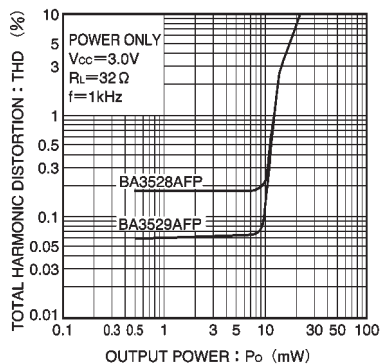


Fig. 27 Total harmonic distortion vs. output voltage

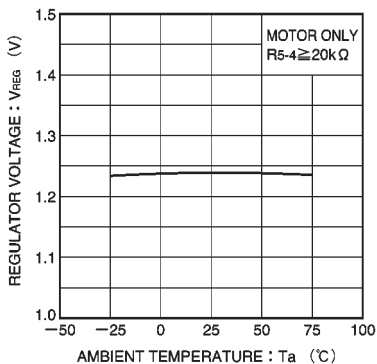


Fig. 28 Regulator voltage vs. ambient temperature

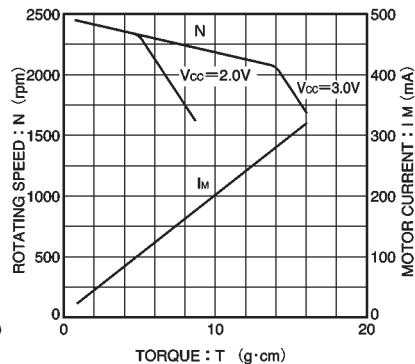
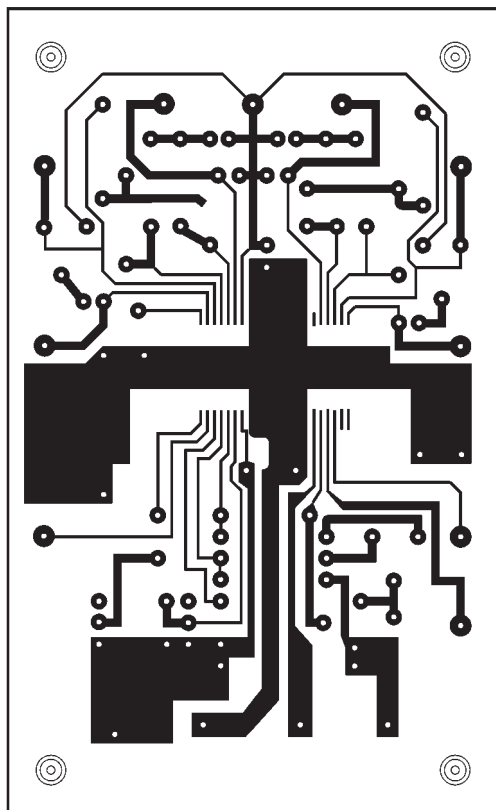


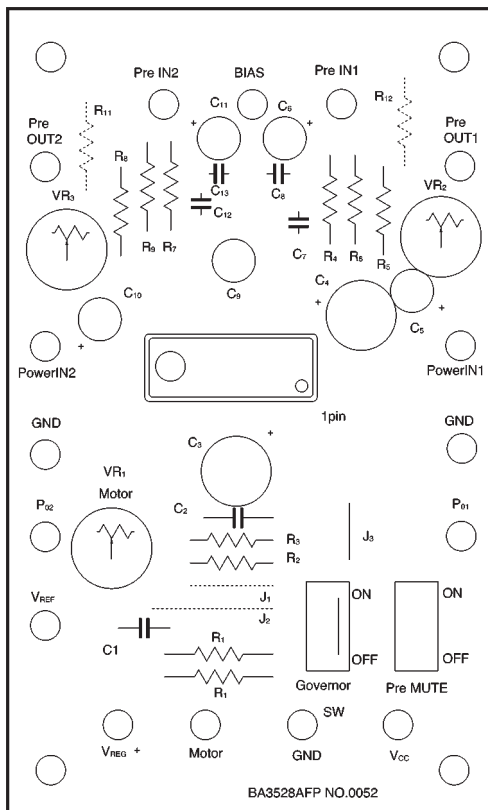
Fig. 29 Rotation speed and motor current vs. torque

●Application board patterns



PCB thickness: 1.6mm
Copper thickness: 35 μ m
Copper side

●Application board component layout



Silk side

● External dimensions (Units: mm)

