

Low-current audio headphone driver

BA3574BFS

The BA3574BFS is a headphone driver with a fixed-gain bass boost circuit and an AVC circuit that keeps the output below a fixed level. It features low current dissipation, and low output noise, and is ideal for use in portable digital audio equipment.

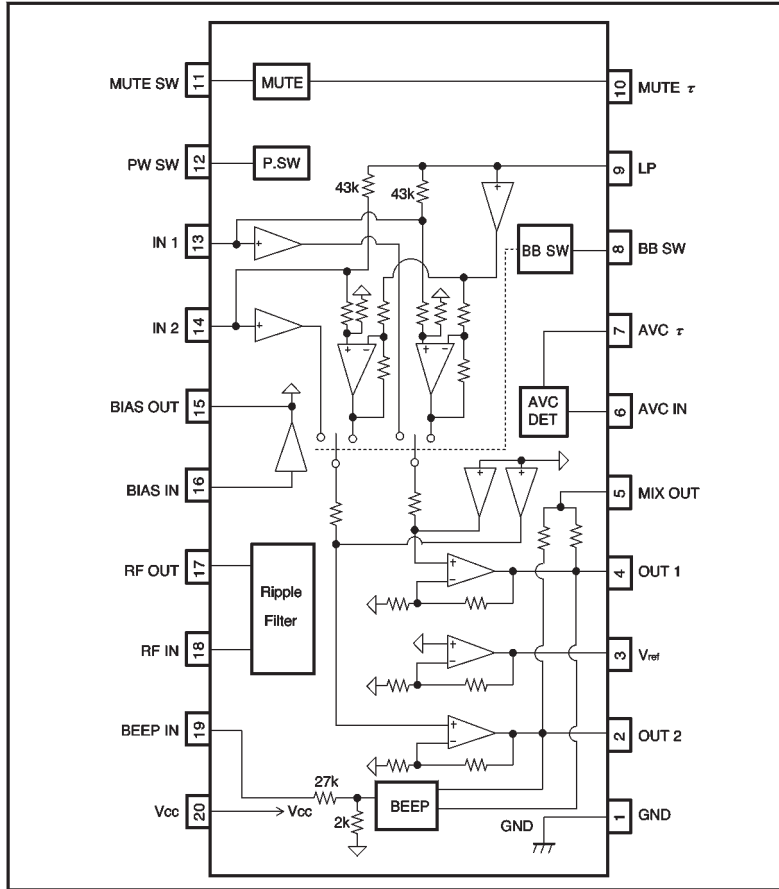
●Applications

Portable CD and MD players

●Features

- 1) Low current dissipation (when $V_{CC} = 2.4V$, the quiescent current is 4.9mA).
- 2) Suitable for use in digital audio equipment (voltage gain: $G_V = 11.8dB$, output noise voltage: $V_{NO} = -102dBm$ typ.).
- 3) Bass boost circuit.
- 4) AVC (Auto Volume Control) circuit, for output limiting.
- 5) Standby switch.
- 6) Mute switch.
- 7) Ripple filter.
- 8) No output coupling capacitor required.
- 9) Beep circuit.
- 10) SSOP-A20 package.

●Block diagram



●Absolute maximum ratings (Ta = 25°C)

Parameter	Symbol	Limits	Unit
Power supply voltage	V _{CC}	9.0	V
Power dissipation	P _d	600*	mW
Operating temperature	T _{opr}	-25~+75	°C
Storage temperature	T _{stg}	-55~+125	°C

* Reduced by 6.0mW for each increase in Ta of 1°C over 25°C.

●Recommended operating conditions (Ta = 25°C)

Parameter	Symbol	Min.	Typ.	Max.	Unit
Power supply voltage	V _{CC}	1.7	—	3.6	V

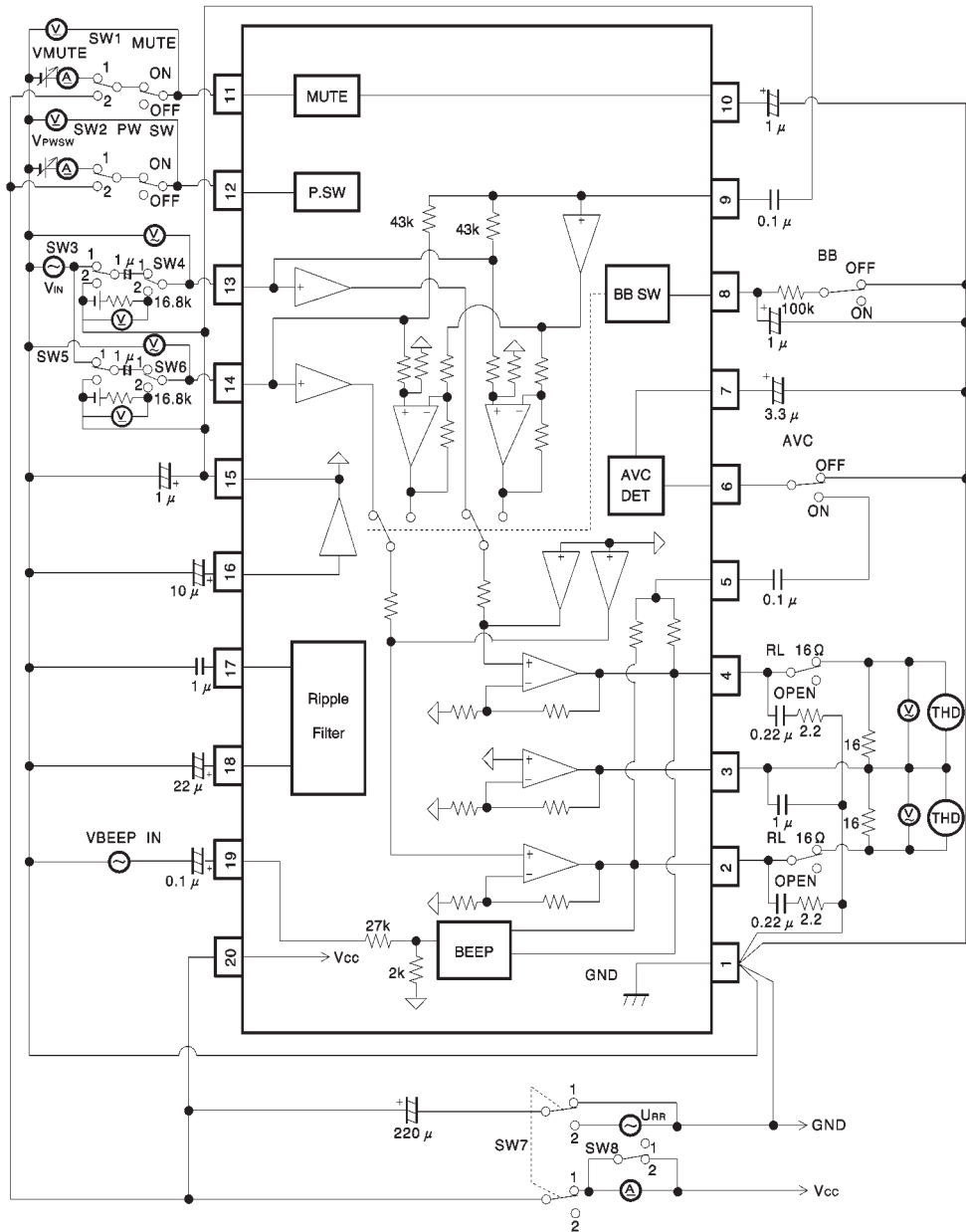
* When V_{CC} ≥ 3.6V, do not exceed the maximum allowable output power (see Fig. 5).

●Electrical characteristics (unless otherwise noted, $T_a = 25^\circ\text{C}$, $V_{CC} = 2.4\text{V}$, $R_L = 16\Omega$, $f = 1\text{kHz}$, and $\text{BB} = \text{OFF}$)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
Circuit current 1	I_{CC1}	—	0.2	3.0	μA	$V_{IN}=0$, $R_L=\text{OPEN}$, $\text{PW SW}=\text{OFF}$
Circuit current 2	I_{CC2}	—	3.1	4.7	mA	$V_{IN}=0$, $R_L=\text{OPEN}$, $\text{MUTE}=\text{ON}$
Circuit current 3	I_{CC3}	—	4.9	7.5	mA	$V_{IN}=0$, $R_L=\text{OPEN}$
Circuit current 4	I_{CC4}	—	5.0	7.8	mA	$V_{IN}=0$, $R_L=\text{OPEN}$, $\text{BB}=\text{ON}$
Circuit current variation	ΔI_{CC}	—	0.3	2.0	mA	$I_{CC4} (R_L=16\Omega) - I_{CC4} (R_L=\text{OPEN})$
Voltage gain	G_V	9.8	11.8	13.8	dB	
Rated output power 1	P_{OUT1}	19	40	—	mW	$\text{THD}=10\%$
Rated output power 2	P_{OUT2}	8	15	—	mW	$\text{THD}=10\%$, $V_{CC}=1.8\text{V}$
Total harmonic distortion	THD	—	0.1	0.5	$\%$	$V_O=0.3V_{\text{rms}}$
Output noise voltage 1	V_{NO1}	—	-102	-97	dBm	$\text{IHF}-\text{A}$, $R_g=0$
Output noise voltage 2	V_{NO2}	—	-89	-84	dBm	$\text{IHF}-\text{A}$, $R_g=0$, $\text{BB}=\text{ON}$
Input resistance	R_{IN}	11.5	16.8	22.0	$\text{k}\Omega$	
Ripple rejection 1	RR1	73	79	—	dB	$f_{RR}=100\text{Hz}$, $V_{RR}=-20\text{dBm}$, $R_g=0$
Ripple rejection 2	RR2	53	63	—	dB	$R_g=0$, $V_{RR}=-20\text{dBm}$, $\text{BB}=\text{ON}$ $f_{RR}=100\text{Hz}$
Ripple rejection 3	RR3	66	79	—	dB	$R_g=0$, $V_{RR}=-20\text{dBm}$, $V_{CC}=1.8\text{V}$ $f_{RR}=100\text{Hz}$
Ripple rejection 4	RR4	43	58	—	dB	$f_{RR}=100\text{Hz}$, $V_{RR}=-20\text{dBm}$, $V_{CC}=1.8\text{V}$ $\text{BB}=\text{ON}$, $R_g=0$
Bass boost	BB	4.5	7.0	9.5	dB	$f=100\text{Hz}$, $V_{IN}=-30\text{dBV}$
AVC level	V_{AVC}	-42.5	-40.5	-38.5	dBV	$V_{IN}=-30\text{dBV}$
Channel separation	CS	24	44	—	dB	$V_O=-10\text{dBV}$
Mute level	ML	80	90	—	dB	$V_{IN}=-20\text{dBV}$
Beep output voltage	V_{BEEP}	1.1	3.0	5.8	mV_{rms}	$V_{BEEP\ IN}=0\text{dBV}$
Power ON voltage	$V_{PW\ ON}$	—	0.95	1.4	V	
Power ON pin current	$I_{PW\ SW}$	—	105	150	μA	$V_{PW\ SW}=3.0\text{V}$
Mute ON voltage	$V_{MUTE\ ON}$	—	0.95	1.4	V	
Mute ON pin current	I_{MUTE}	—	105	150	μA	$V_{MUTE}=3.0\text{V}$

©Not designed for radiation resistance.

● Measurement circuit



Units:
 Resistance : Ω ($\pm 1\%$)
 Capacitance (film) : F ($\pm 1\%$)
 Capacitance (electrolytic): F ($\pm 5\%$)

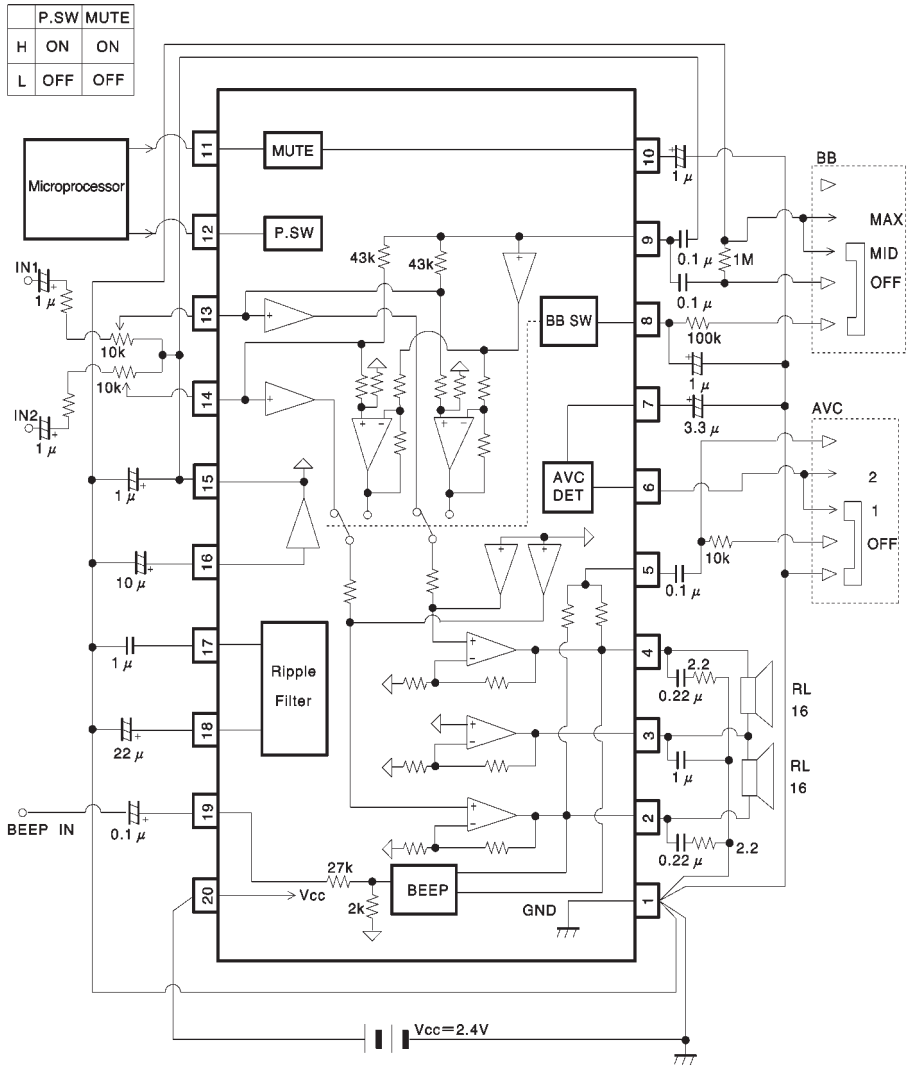
Fig. 1

● Measurement circuit switch table

Parameter	Symbol	MUTE	PwSw	BB	AVC	R _L	SW1	SW2	SW3	SW4	SW5	SW6	SW7	SW8
Circuit current 1	I _{cc1}	OFF	OFF	OFF	OFF	OPEN	2	2	2	1	2	1	1	1
Circuit current 2	I _{cc2}	ON	ON	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
Circuit current 3	I _{cc3}	OFF	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
Circuit current 4	I _{cc4}	↓	↓	ON	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
Circuit current variation	ΔI _{cc}	↓	↓	↓	↓	16Ω OPEN	↓	↓	↓	↓	↓	↓	↓	↓
Voltage gain	G _v	↓	↓	OFF	↓	16Ω	↓	↓	1	↓	1	↓	↓	2
Rated output power 1	P _{out1}	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
Rated output power 2	P _{out2}	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
Total harmonic distortion	THD	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
Output noise voltage 1	V _{No1}	↓	↓	↓	↓	↓	↓	↓	2	↓	2	↓	↓	↓
Output noise voltage 2	V _{No2}	↓	↓	ON	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
Input resistance	R _{in}	↓	↓	OFF	↓	↓	↓	↓	1	2	1	2	↓	↓
Ripple rejection ratio 1	RR1	↓	↓	↓	↓	↓	↓	↓	2	1	2	1	2	↓
Ripple rejection ratio 2	RR2	↓	↓	ON	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
Ripple rejection ratio 3	RR3	↓	↓	OFF	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
Ripple rejection ratio 4	RR4	↓	↓	ON	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
Bass boost	BB	↓	↓	↓	↓	↓	↓	↓	1	↓	1	↓	1	↓
AVC level	V _{AVC}	↓	↓	OFF	ON	↓	↓	↓	↓	↓	↓	↓	↓	↓
Channel separation	CS	↓	↓	↓	OFF	↓	↓	↓	1 2	↓	2 1	↓	↓	↓
Mute level	ML	ON	↓	↓	↓	↓	↓	↓	1	↓	1	↓	↓	↓
Beep output voltage	V _{BEEP}	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
Power ON voltage	V _{PW ON}	OFF	↓	↓	↓	↓	1	1	↓	↓	↓	↓	↓	↓
Power ON pin current	I _{PW SW}	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
Mute ON voltage	V _{MUTE ON}	ON	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
Mute pin current	I _{MUTE}	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓

●Application example 1

(headphone stereo with bass boost and output limiting)

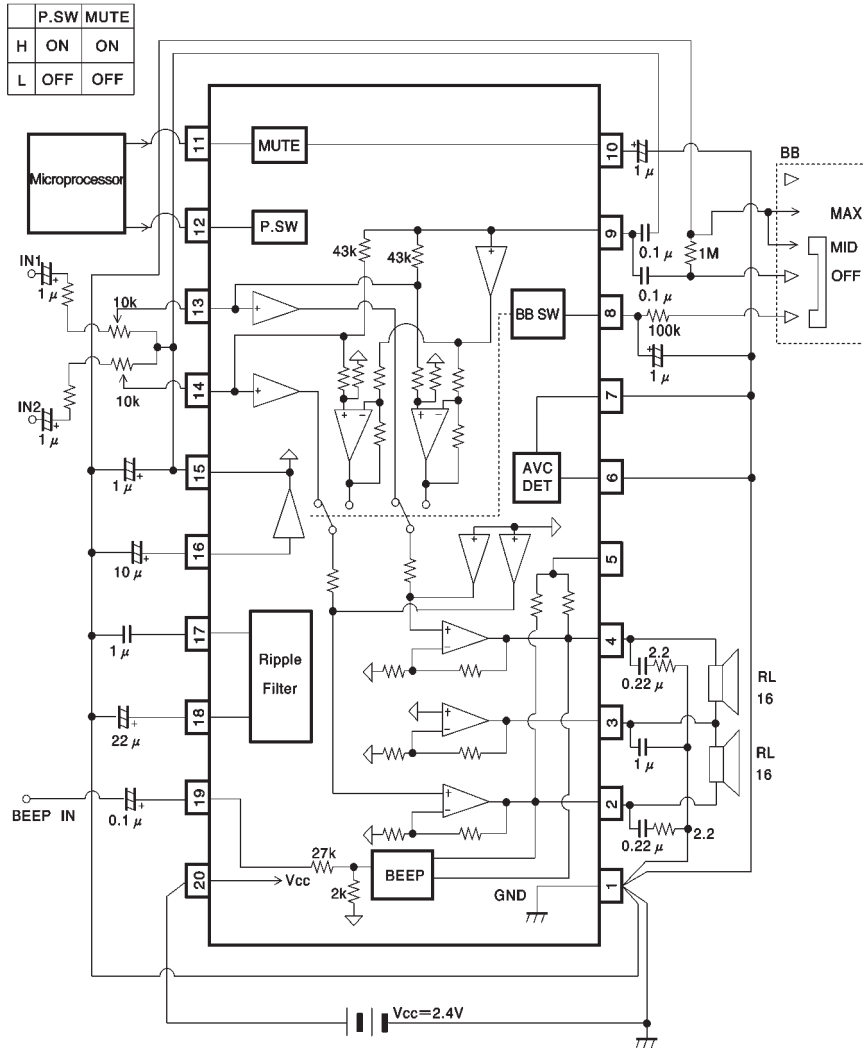


Units:
 Resistance : Ω (±5%)
 Capacitance (film) : F (±10%)
 Capacitance (electrolytic) : F (±20%)

Fig. 2

●Application example 2

(headphone stereo with bass boost)

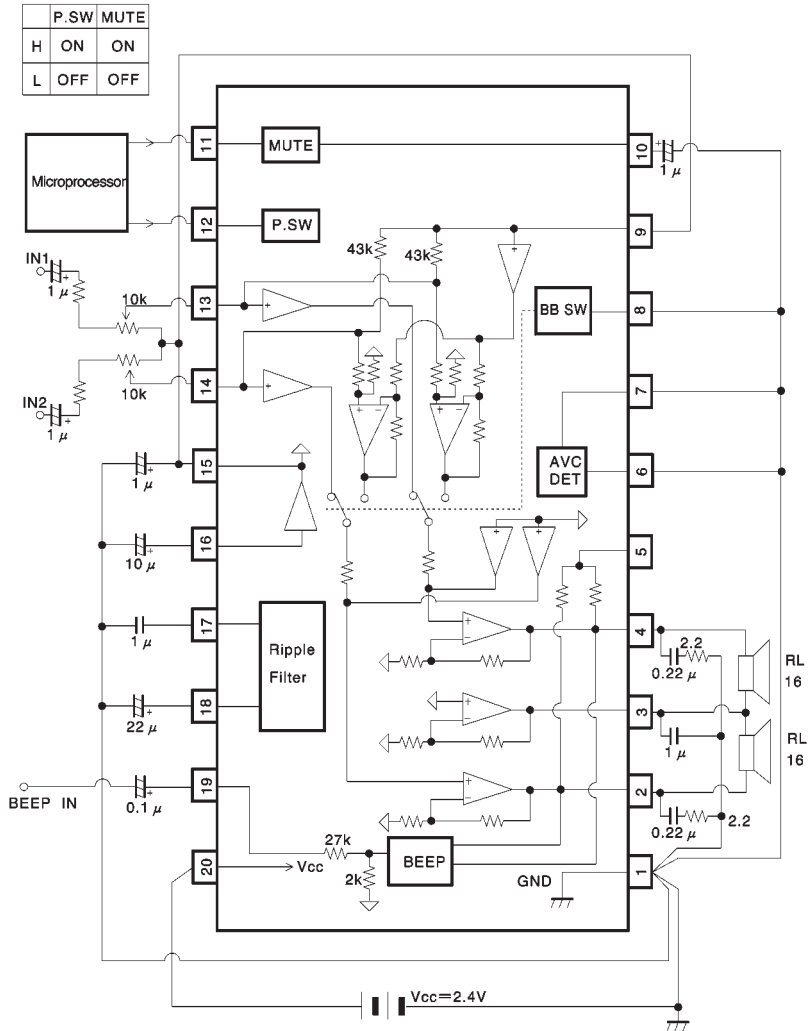


Units:
 Resistance : Ω (±5%)
 Capacitance (film) : F (±10%)
 Capacitance (electrolytic) : F (±20%)

Fig. 3

●Application example 3

(headphone stereo)



Units:
 Resistance : Ω ($\pm 5\%$)
 Capacitance (film) : F ($\pm 10\%$)
 Capacitance (electrolytic) : F ($\pm 20\%$)

Fig. 4

● Operation notes

(1) Application circuits

Provided the recommended circuit constants are used, the application circuits should function correctly. However, we recommend that you confirm the characteristics of the circuits in actual use. If you change the circuit constants, check both the static and transient characteristics of the circuit, and allow sufficient margin to accommodate variations between both ICs and external components.

In particular, the capacitors connected to the OUT 1, OUT 2, and Vref pins must have low impedance at high frequency.

(2) Wiring of PCB

The PCB pattern for the external components should be designed carefully to prevent oscillation and degradation of the circuit characteristics. Keep the wiring tracks as short as possible, and ensure that there is no impedance between the common connections.

(3) Recommended power supply voltage range

The curves in Fig. 5 below show the maximum allowable power output ($P_{O(Max.)}/ch$) plotted against the supply voltage (V_{CC}) for different values of ambient temperature (T_a). When $V_{CC} \geq 3.6V$, operate the IC in the region below the dotted line, and do not exceed it.

If the maximum allowable power output for each channel ($P_{O(Max.)}/ch$) is exceeded, the internal power consumption will exceed the power dissipation capacity of the package, and destroy the IC.

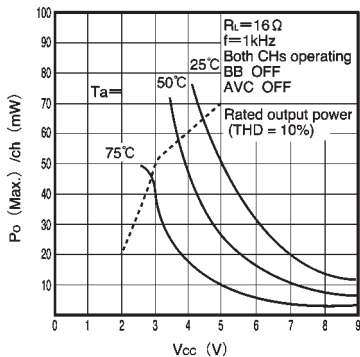
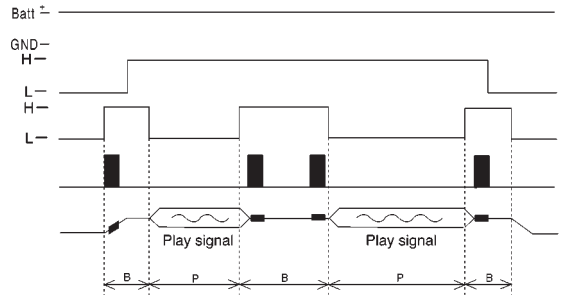


Fig. 5 Maximum allowable power output per channel ($P_{O(Max.)}/ch$) vs. power supply voltage (V_{CC}).

(4) Switching noise prevention

Operate the BA3574BFS according to the timing diagram given in Fig. 6 below to prevent a “pop” sound from being output to the headphones.



- V_{CC} (20pin)
- PWSW (12pin)
- MUTE (11pin)
- BEEP IN (19pin)
- OUT1, 2 (2, 4pin)

B: BEEP amplifier operates
P: PWR amplifier operates

PWSW (12pin)	MUTE (11pin)	PWR AMP	BEEP AMP
L	L	OFF	OFF
L	H	OFF	ON
H	H	OFF	ON
H	L	ON	OFF

Fig. 6

(5) BIAS OUT (pin 15)

The internal operating point voltage of the BA3574BFS is supplied from BIAS OUT (pin 15). The current capacity is limited, so do not use this as the operating point for external circuits.

●Electrical characteristics curves

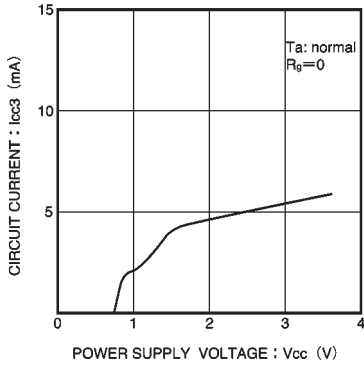


Fig. 7 Quiescent current vs. power supply voltage

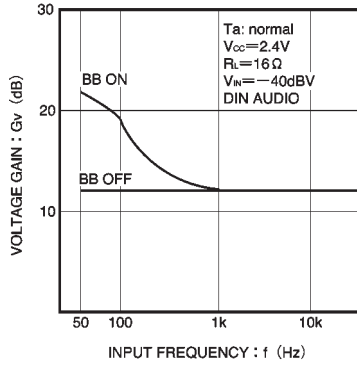


Fig. 8 Voltage gain vs. frequency

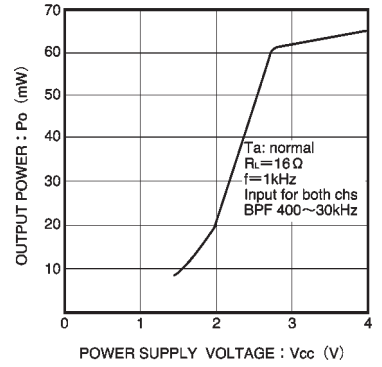


Fig. 9 Rated output power vs. power supply voltage

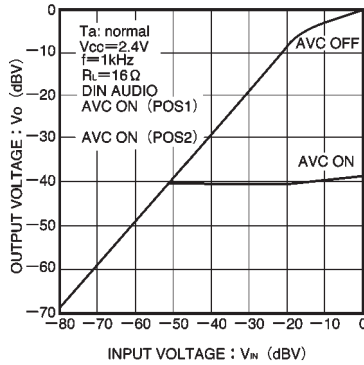


Fig. 10 AVC characteristics

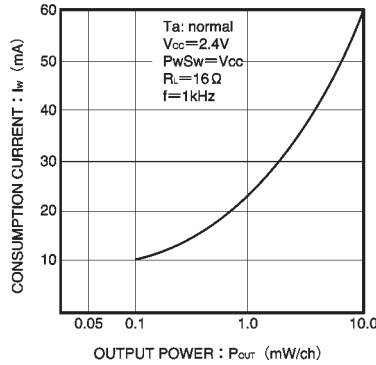


Fig. 11 Current dissipation vs. output power

● External dimensions (Units: mm)

