Low-current audio headphone driver
BA3575FS

The BA3575FS is a headphone driver with an AVC circuit that keeps the output below a fixed level. It features low current consumption, and low output noise, and is ideal for use in portable digital audio equipment.

●Applications
Portable CD players

●Features
1) Low current consumption (when V_{CC} = 2.4 V, 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) ATT circuit (gain switch).
4) AVC (Auto Volume Control) circuit, for output limiting.
5) Internal standby switch.
6) Internal mute switch.
7) Internal ripple filter.
8) No output coupling capacitor required.
9) Internal beep circuit.
10) SSOP-A20 package.

●Absolute maximum ratings (Ta = 25°C)

Parameter	Symbol	Limits	Unit
Power supply voltage	V_{CC}	9.0	V
Power dissipation	Pd	600*1	mV
Operating temperature	Topr	−25～+75	℃
Storage temperature	Tstg	−55～+125	℃

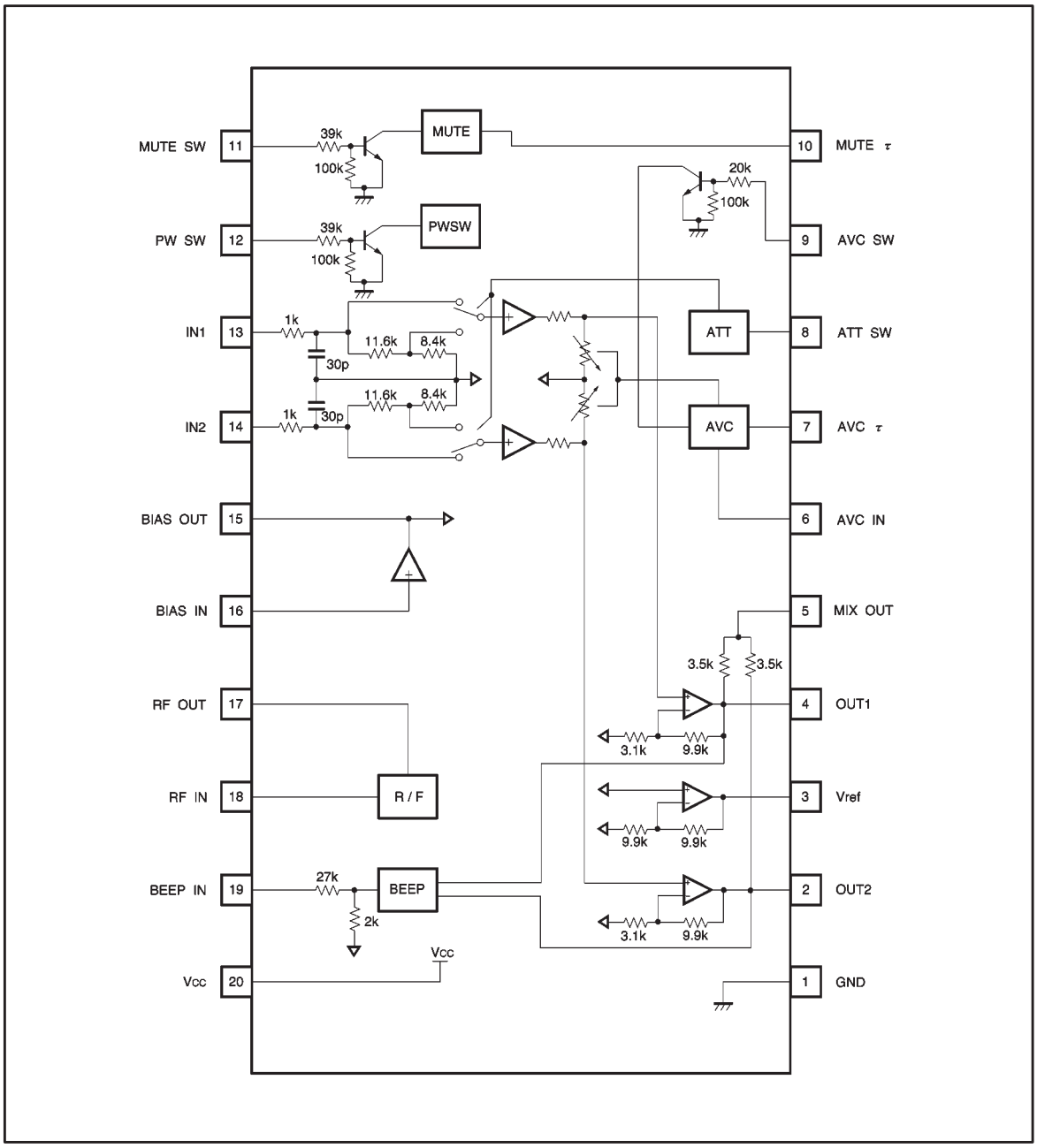
*1 Reduced by 6.0mW for each increase in Ta of 1℃ over 25℃.

●Recommended operating conditions (Ta = 25°C)

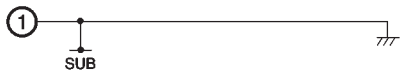
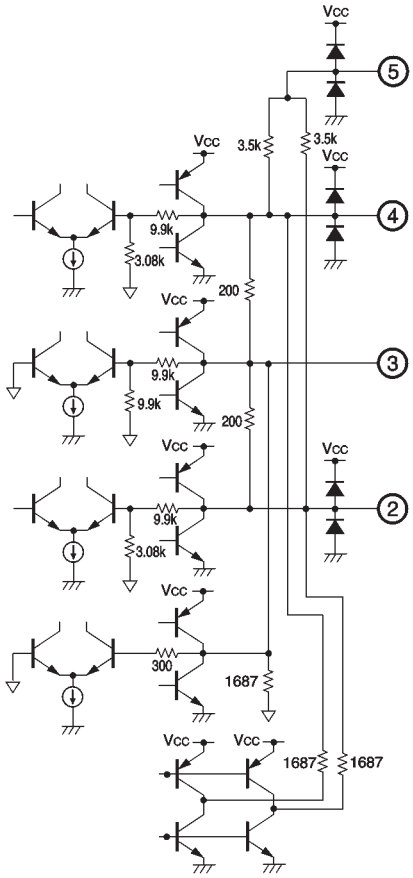
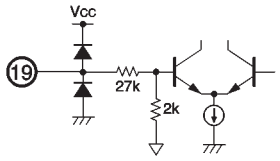
Parameter	Symbol	Min	Max	Unit
Power supply voltage*2	V_{CC}	1.7	3.6	V

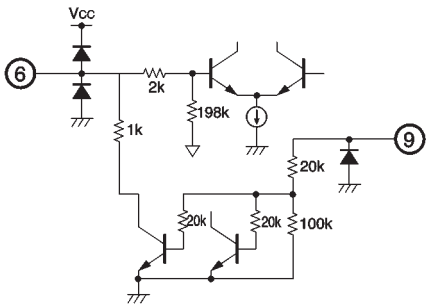
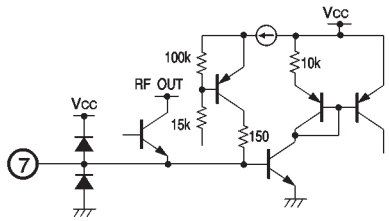
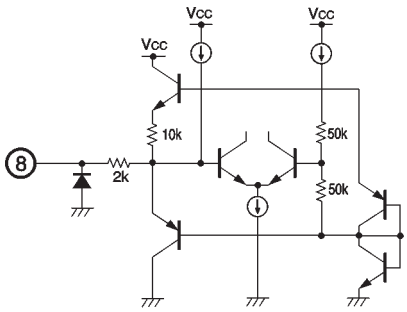
*2 When $V_{CC} \geqq 3.6V$, do not exceed the maximum allowable output power.

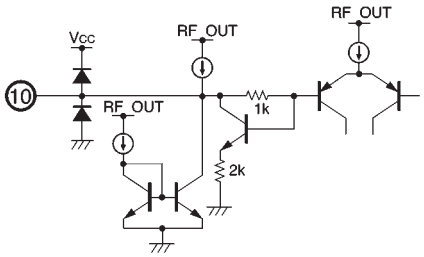
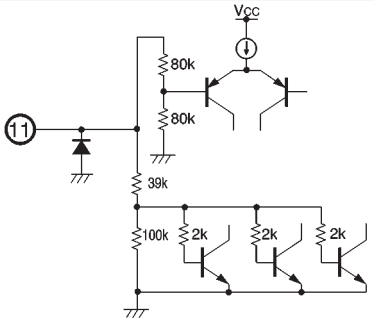
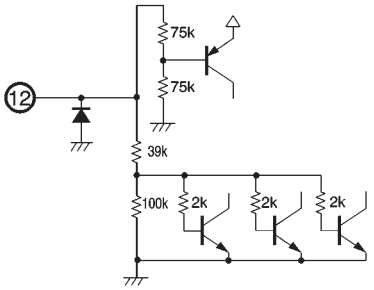
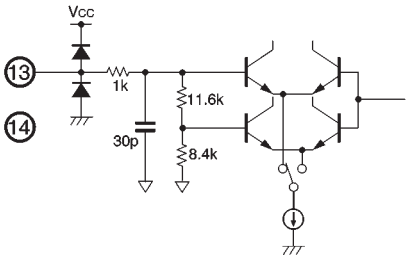
●Block diagram

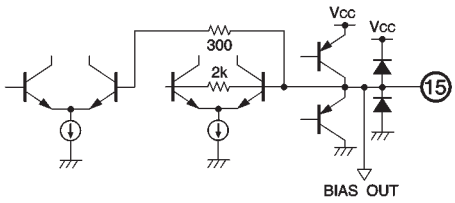
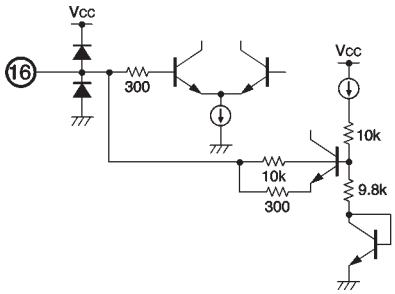
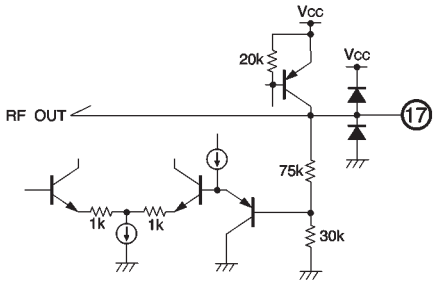
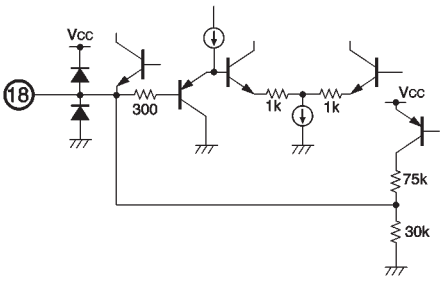


●Pin descriptions

Pin No.	Pin name	I / O	DC voltage (V)	Equivalent circuit	Function
1	GND	I	0		Ground (SUB pin)
2	OUT2	O	1.23		Power amplifier output Beep amplifier output (ch2)
3	Vref	O	1.23		Center amplifier output
4	OUT1	O	1.23		Power amplifier output Beep amplifier output (ch1)
5	MIX OUT	O	1.23		Power amplifier MIX output
19	BEEP IN	I	1.23		Beep amplifier input

Pin No.	Pin name	I / O	DC voltage (V)	Equivalent circuit	Function
6	AVC IN	I	1.23		AVC detector input
9	AVC SW	I	0 (OPEN)		AVC ON/OFF switch
7	AVC τ	I / O	When detecting 0.7 Not detecting 0		AVC detector output smoothing
8	ATT SW	I	–		Gain switch

Pin No.	Pin name	I / O	DC voltage (V)	Equivalent circuit	Function
10	MUTE τ	I / O	MUTE ON 0.1 MUTE OFF 0.7		Mute switch time constant
11	MUTE SW	I	0 (OPEN)		Mute ON/OFF switch
12	PW SW	I	0 (OPEN)		Power ON/OFF switch
13	IN1	I	1.23		Preamplifier input (ch2)
14	IN2	I	1.23		Preamplifier input (ch1)

Pin No.	Pin name	I / O	DC voltage (V)	Equivalent circuit	Function
15	BIAS OUT	O	1.23		Bias amplifier output
16	BIAS IN	I	1.23		Bias amplifier input
17	RF OUT	O	2.15		Ripple filter amplifier output
18	RF IN	I	0.6		Ripple filter amplifier input
20	Vcc	I	2.4		Power supply input

●Electrical characteristics(unless otherwis noted, Ta = 25°C, V_{CC} = 2.4V, R_L = 16Ω, f = 1kHz, DIN AUDIO, PWSW = ON, MUTE = OFF, ATT = OFF, and AVC = OFF)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Coniditions
Circuit current 1	Icc1	—	0.2	3.0	μA	V_{IN}=0, R_L=OPEN, PWSW=OFF, AVCSW=OPEN
Circuit current 2	Icc2	—	3.1	4.7	mA	V_{IN}=0, R_L=OPEN, MUTE=ON, AVCSW=OPEN
Circuit current 3	Icc3	—	4.9	7.5	mA	V_{IN}=0, R_L=OPEN, AVCSW=OPEN
Operating circuit current	I_{IN}	—	17.0	26.0	mA	P_{OUT}=0.5mW, R_L=16Ω
Voltage gain 1	Gv1	9.8	11.8	13.8	dB	
Voltage gain 2	Gv2	2.3	4.3	6.3	dB	ATT=ON
Rated output power 1	Pout1	19	40	—	mW	THD=10%
Rated output power 2	Pout2	8	15	—	mW	THD=10%, Vcc=1.8V
Total harmonic distortion	THD	—	0.1	0.5	%	V_O=0.3V_{rms}
Output noise voltage	V_{NO}	—	−102	−97	dBm	IHF-A, Rg=0
Input resistance	R_{IN}	14.5	21.0	27.5	kΩ	
Ripple rejection 1	RR1	73	79	—	dB	f_{RR}=100Hz, V_{RR}=−20dBm, Rg=0
Ripple rejection 2	RR2	66	79	—	dB	Rg=0, V_{RR}=−20dBm, Vcc=1.8V f_{RR}=100Hz
AVC level	V_{AVC}	−42.5	−40.5	−38.5	dBV	V_{IN}=−30dBV
Channel separation	CS	24	44	—	dB	V_O=−10dBV
Mute level	ML	80	90	—	dB	V_{IN}=−20dBV
Beep output voltage	V_{BEEP}	1.1	3.0	5.8	mV_{rms}	$V_{BEEP\ IN}$=0dBV
Power ON voltage	$V_{PW\ ON}$	—	0.95	1.4	V	
Power ON pin current	$I_{PW\ SW}$	—	105	150	μA	$V_{PW\ SW}$=3.0V
Mute ON voltage	$V_{MUTE\ ON}$	—	0.95	1.4	V	
Mute pin current	I_{MUTE}	—	105	150	μA	V_{MUTE}=3.0V
AVC OFF voltage	$V_{AVC\ OFF}$	—	0.85	1.3	V	
AVC pin current	$I_{AVC\ OFF}$	—	85	130	μA	V_{AVC}=3.0V

◎Not desiged for radiation resistance.

●Measurement circuit

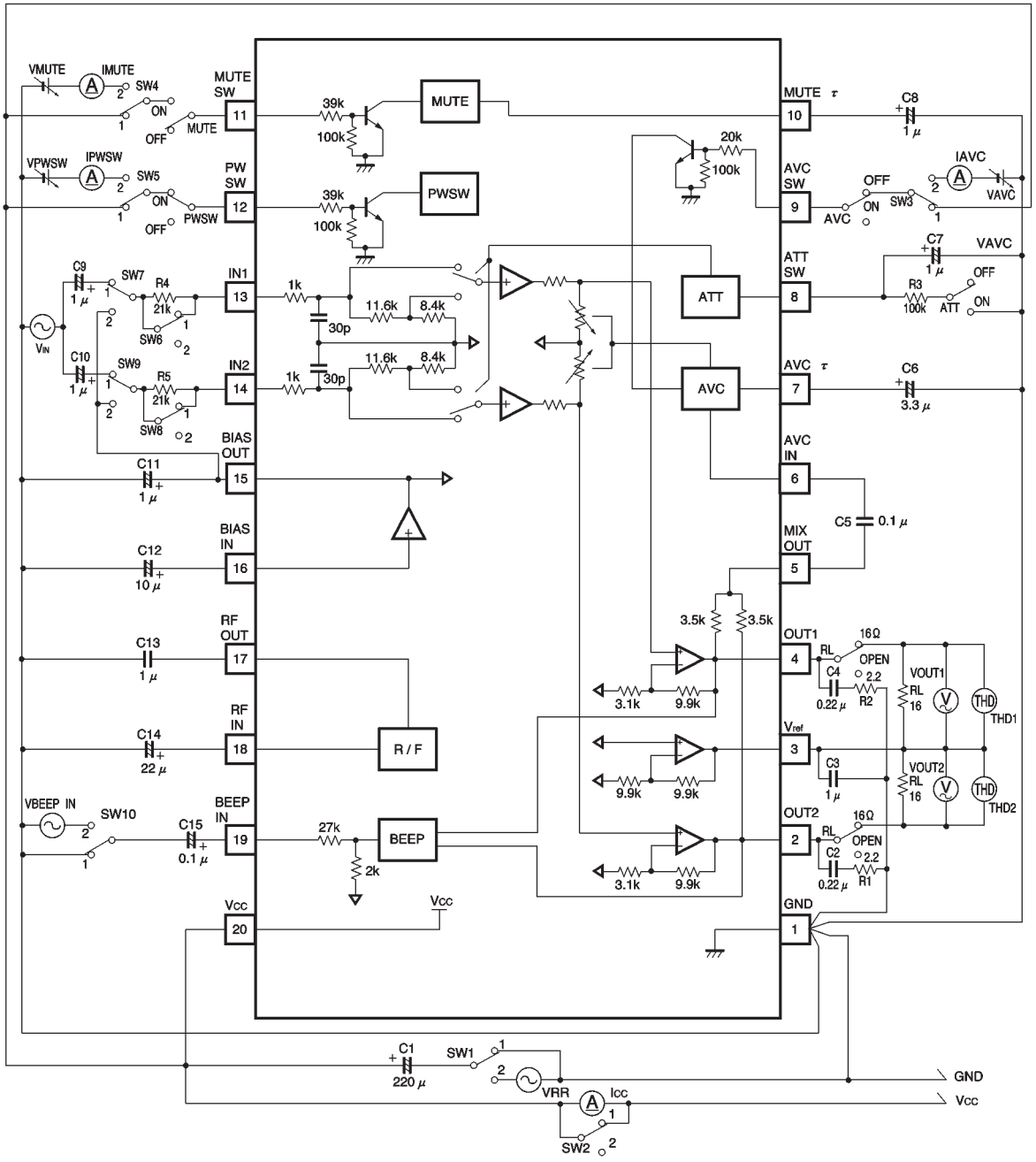


Fig.1

Units
Resistance : Ω (±1%)
Capacitance (film) : F (±1%)
Capacitance (electrolytic) : F (±5%)

●Measurement circuit switch table (Fig.1)

Parameter	Symbol	MUTE	PwSw	ATT	AVC	R_L	SW1	SW2	SW3	SW4	SW5	SW6	SW7	SW8	SW9	SW10
Circuit current 1	Icc1	OFF	OFF	OFF	ON	OPEN	1	2	1	1	1	1	2	1	2	1
Circuit current 2	Icc2	ON	ON	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
Circuit current 3	Icc3	OFF	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
Operating circuit current	I_{IN}	↓	↓	↓	OFF	16Ω	↓	↓	↓	↓	↓	↓	1	↓	1	↓
Voltage gain 1	Gv1	↓	↓	↓	↓	↓	↓	1	↓	↓	↓	↓	↓	↓	↓	↓
Voltage gain 2	Gv2	↓	↓	ON	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
Rated output power 1	$P_{OUT}1$	↓	↓	OFF	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
Rated output power 2	$P_{OUT}2$	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
Total harmonic distortion	THD	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
Output noise voltage	V_{NO}	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	2	↓	2	↓
Input resistance	R_{IN}	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	2	1	2	1	↓
Ripple rejection 1	RR1	↓	↓	↓	↓	↓	2	↓	↓	↓	↓	1	2	1	2	↓
Ripple rejection 2	RR2	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
AVC level	V_{AVC}	↓	↓	↓	ON	↓	1	↓	↓	↓	↓	↓	1	↓	1	↓
Channel separation	CS	↓	↓	↓	OFF	↓	↓	↓	↓	↓	↓	↓	1 2	↓	2 1	↓
Mute level	ML	ON	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	1	↓	1	2
Beep output voltage	V_{BEEP}	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	2	↓	2	1
Power ON voltage	$V_{PW\ ON}$	OFF	↓	↓	↓	↓	↓	↓	↓	↓	2	↓	1	↓	1	↓
Power ON pin current	$I_{PW\ SW}$	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	2	↓	2	↓
Mute ON voltage	$V_{MUTE\ ON}$	ON	↓	↓	↓	↓	↓	↓	↓	2	1	↓	↓	↓	↓	2
Mute pin current	I_{MUTE}	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	1
AVC OFF voltage	$V_{AVC\ OFF}$	OFF	↓	↓	↓	↓	↓	↓	2	1	↓	↓	1	↓	1	↓
AVC pin current	$I_{AVC\ OFF}$	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	2	↓	2	↓

●Application example

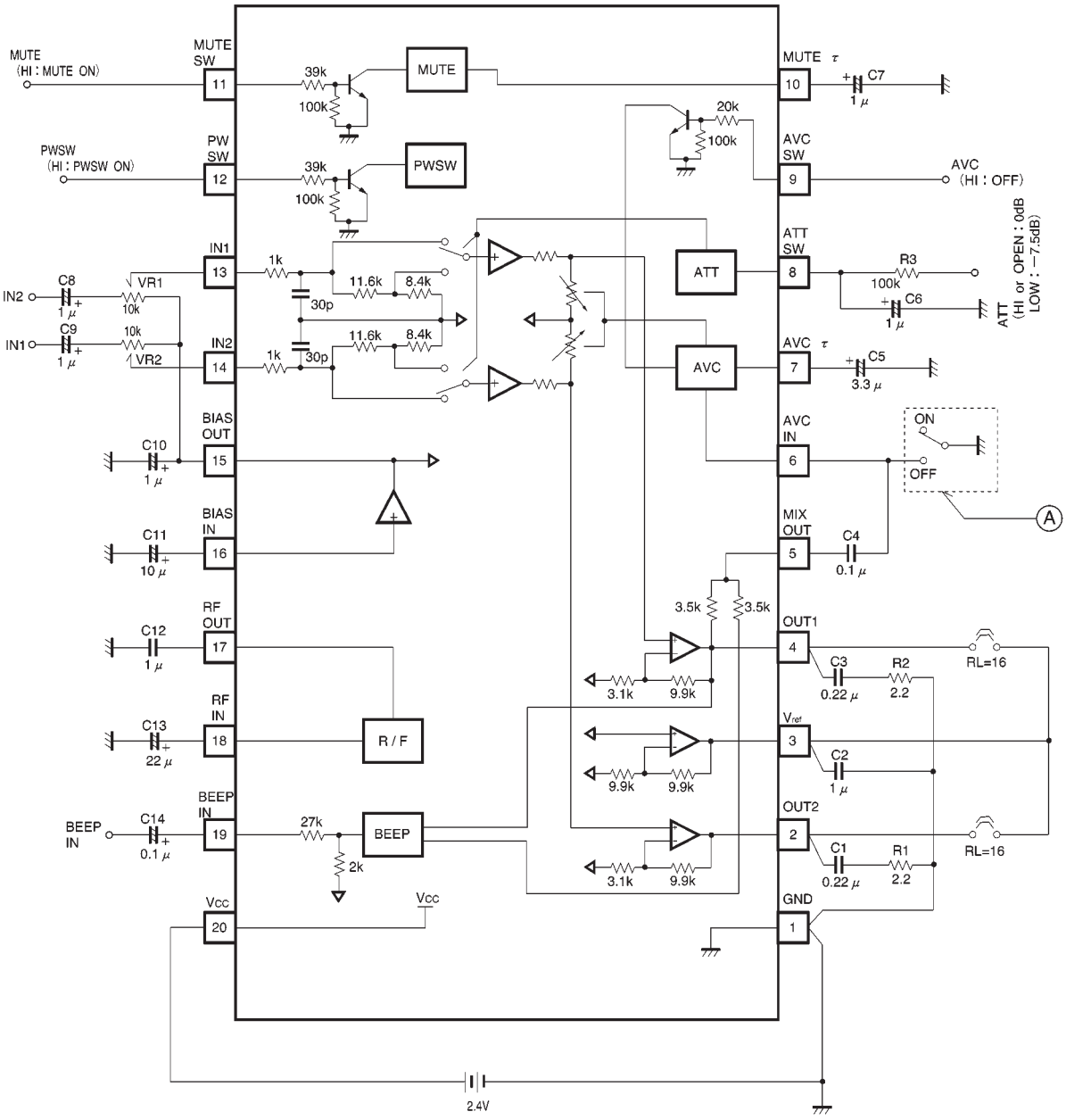


Fig.2

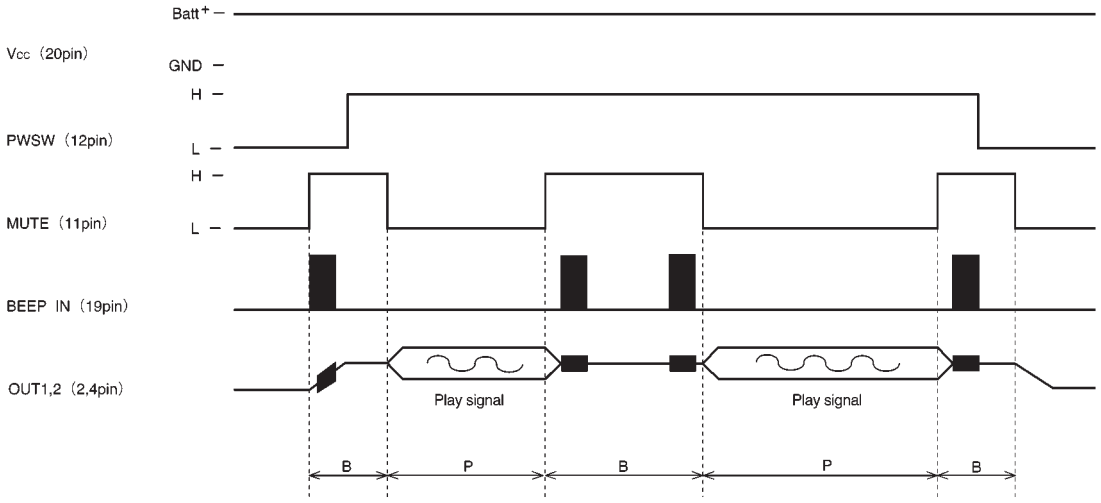
Note: AVC on/off control is also possible using switch A.

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

●Application notes

(1) "Pop" sound

By operating the BA3575FS according to the timing chart shown in Fig.3, it is possible to suppress generation of "pop" noise in the headphone output.



B: BEEP AMPLIFIER operating

P: PWR AMPLIFIER operating

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.3 Time chart

(2) 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 V_{REF} pins must have low impedance at high frequency, and have sufficient margin in their temperature characteristics.

Also, use an electrolytic or tantalum capacitor for the capacitor connected to the BIASOUT terminal.

(3) 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.

The ripple filter pins (1 and 2) and the bias amplifier pins (3 and 4) cannot be used for external power supplies or reference voltages.

(4) Recommended operating conditions

The curves in Fig.4 below show the maximum allowable power output ($P_{O\,(Max.)}$/ch) plotted against the supply voltage (V_{CC}) for different values of ambient temperature (Ta). When $V_{CC} \geqq 3.6$ V, 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.

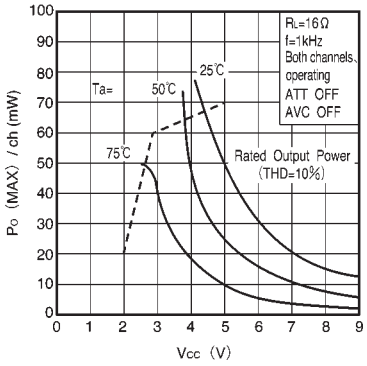


Fig.4 Maximum allowable power output per channel (P_O (MAX.) / ch) vs. supply voltage (V_{CC})

●Electrical characteristics curves

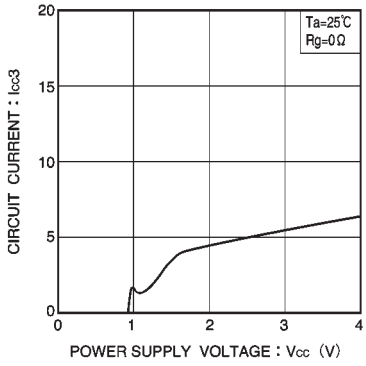


Fig.5 Quiescent current vs. power supply voltage

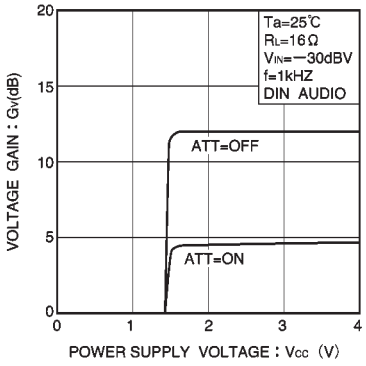


Fig.6 Voltage gain vs. power supply voltage

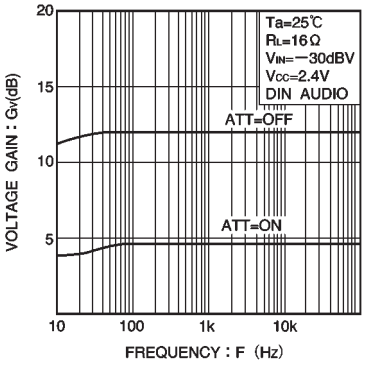


Fig.7 Voltage gain vs. frequency

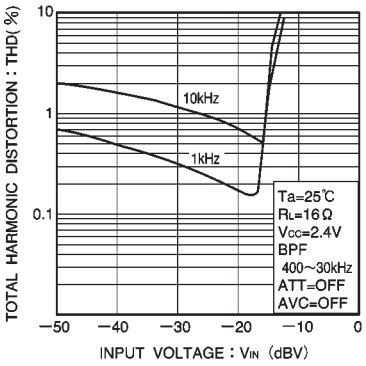


Fig.8 Total harmonic distortion vs. input voltage

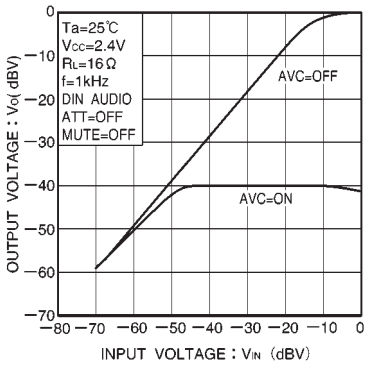


Fig.9 Output voltage vs. input voltage

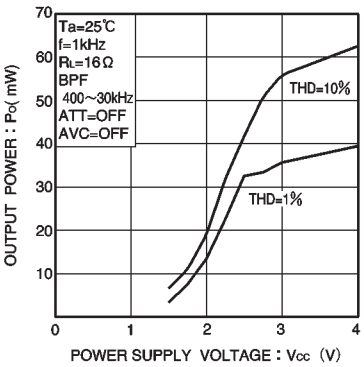
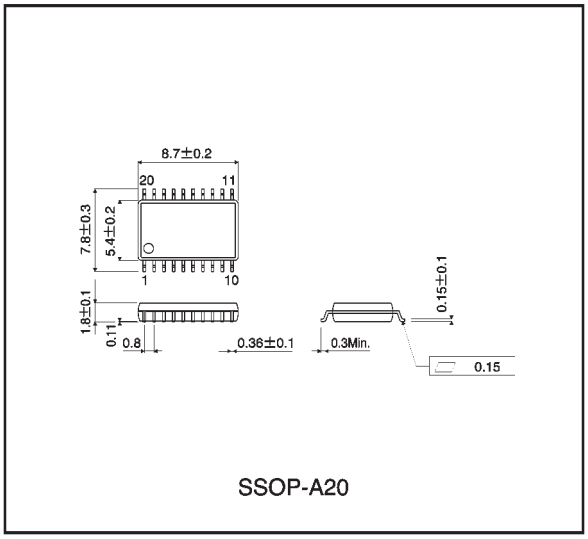


Fig.10 Output voltage vs. power supply voltage

●External dimensions (Units: mm)



SSOP-A20