

# Headphone driver for digital audio

## BA3578FS / BA3579FS

The BA3578FS and BA3579FS are headphone drivers with internal an LPF and fixed bass boost circuit for multi-bit D / A converters.

### ●Applications

Portable CD players

### ●Features

- 1) Suitable for use in digital audio equipment (line-out output noise voltage:  $18\mu\text{V}_{\text{rms}}$ ,  $S / N = 95\text{dB}$  Typ.).
- 2) Internal LPF for multi-bit D / A converters ( $f_c = 34\text{kHz}$ ,  $-12\text{dB} / \text{oct.}$  Typ.).
- 3) Headphone mute function.
- 4) Internal BB (bass boost) circuit.
- 5) Internal supply current for line-mute transistor.
- 6) No need for output oscillation preventive measures.
- 7) Internal standby switch.

### ●Absolute maximum ratings (Ta = 25°C)

Parameter	Symbol	Limits	Unit
Power supply voltage	$AV_{DD}$	5.5	V
	$PV_{CC}$	5.5	V
Power dissipation	$P_d$	600*1	mW
Operating temperature	$T_{opr}$	-20~+60	°C
Storage temperature	$T_{stg}$	-55~+125	°C

\*1 Reduced by 6mW for each increase in Ta of 1°C over 25°C.

### ●Recommended operating conditions

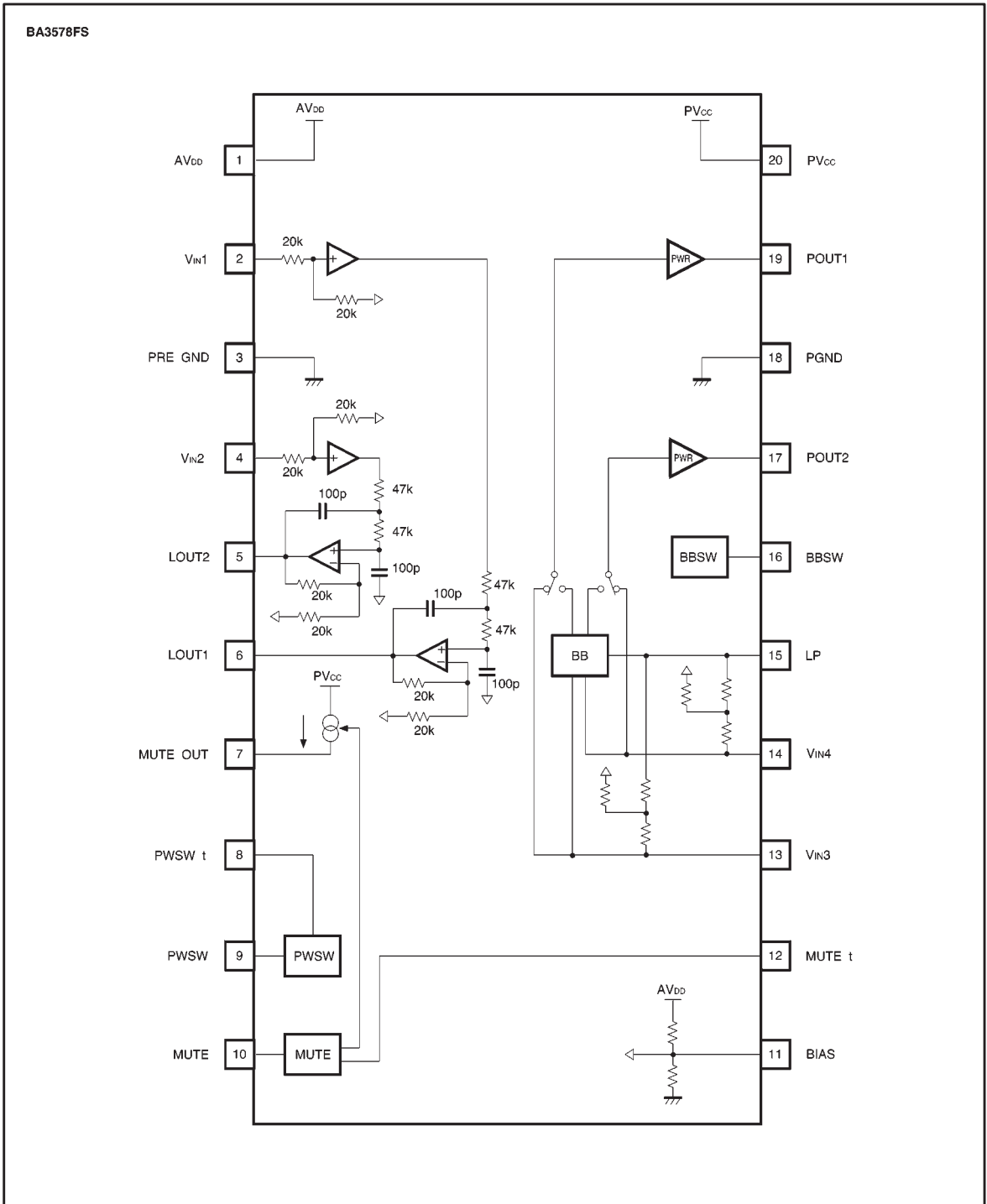
Parameter	Symbol	Limits	Unit
Power supply voltage	$AV_{DD}$	3.6	V
	$PV_{CC}$	3.6	V

### ●Recommended operating range

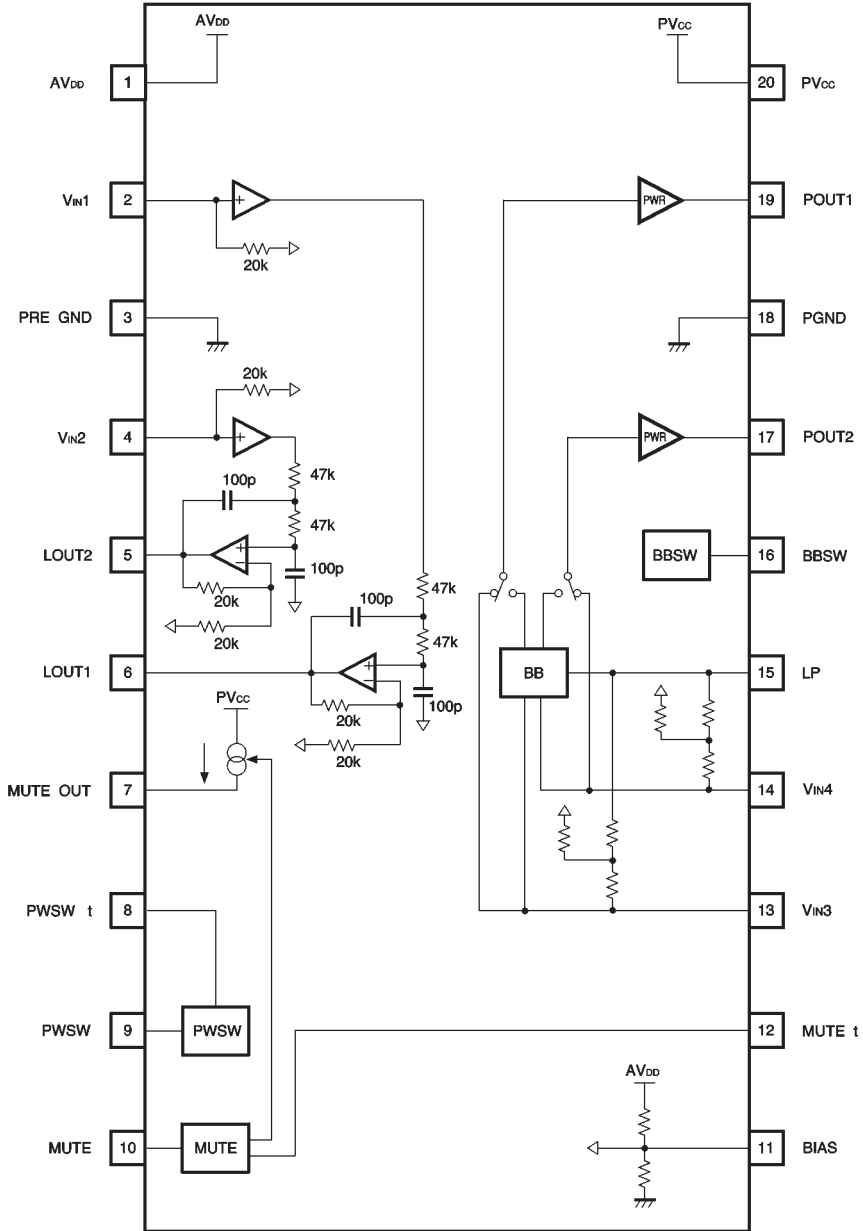
Parameter	Symbol	Limits	Unit
Power supply voltage	$AV_{DD}$	2.8~5.0	V
	$PV_{CC}$	2.8~5.0*2	V

\*2 In order to use the headphone output to its optimum performance, have the power supply voltage such that  $PV_{CC} \geq AV_{DD} - 0.3V$

● Block diagram



BA3579FS



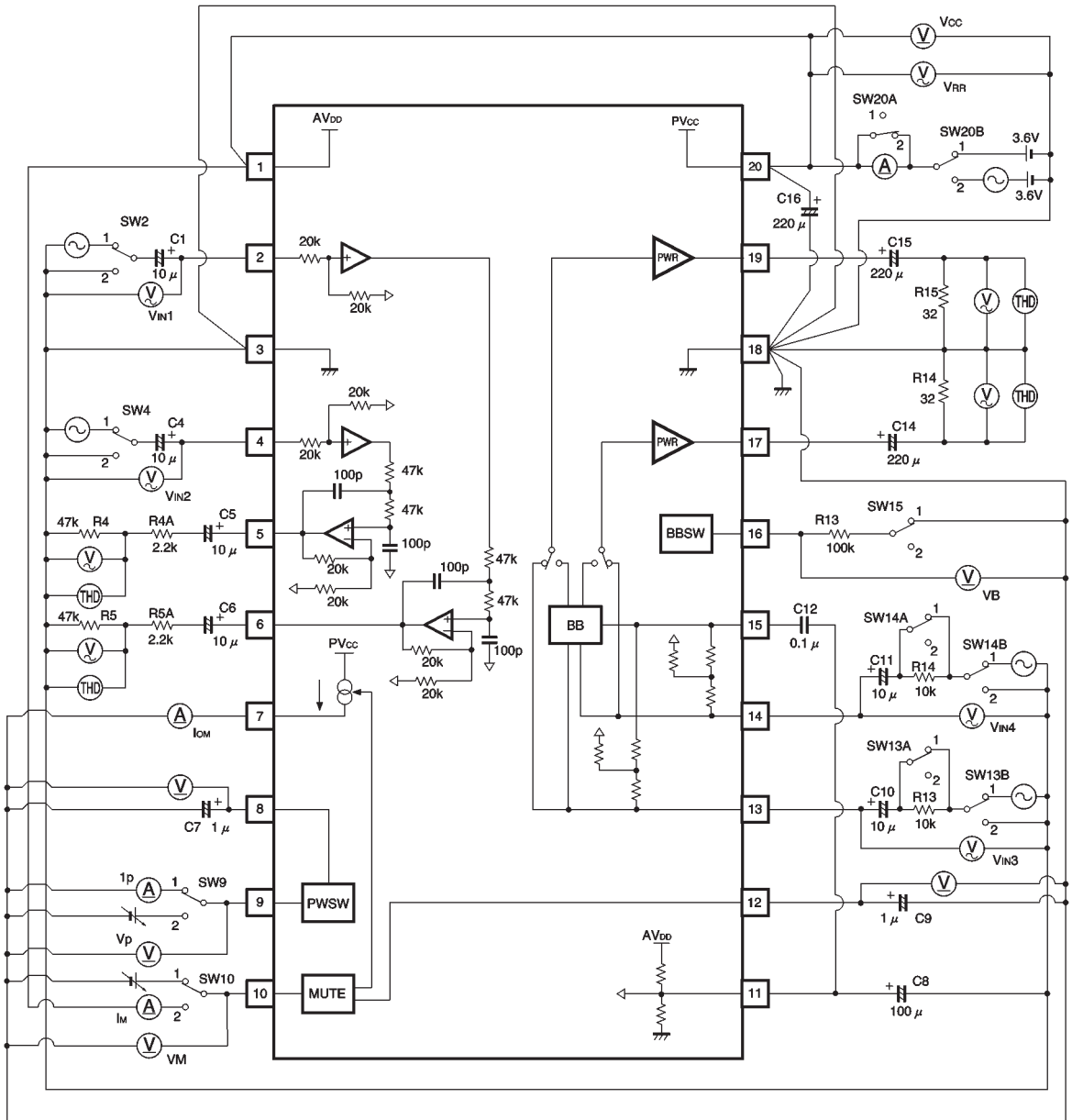
- Electrical characteristics (Unless otherwise noted, Ta = 25°C, PV<sub>CC</sub> = AV<sub>DD</sub> = 3.6V, f = 1kHz, PwSw = ON, MUTE = OFF, BB = OFF, Line R<sub>L1</sub> = 47kΩ, headphone R<sub>L2</sub> = 32Ω, filter = DIN AUDIO, line-out measurements are with V<sub>IN3</sub> and 4 = 0V)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Coniditions
Circuit current	I <sub>CC</sub>	4.5	7.5	11.5	mA	V <sub>IN</sub> =0
Power ON voltage	V <sub>P</sub>	2.0	2.8	—	V	
Power ON pin current	I <sub>P</sub>	—	60	110	μA	V <sub>PWSW</sub> =0V
Mute ON voltage	V <sub>M</sub>	—	0.8	1.4	V	
Mute pin current	I <sub>M</sub>	—	110	190	μA	V <sub>MUTE</sub> =AV <sub>DD</sub>
Mute output current	I <sub>OM</sub>	1.0	2.0	—	mA	V <sub>MUTE</sub> =AV <sub>DD</sub>
Bass boost OFF voltage	V <sub>B</sub>	0.5	0.7	—	V	
〈Line-out〉 (BA3578FS)						
Voltage gain	G <sub>V1</sub>	−2.4	−0.4	1.6	dB	V <sub>IN1</sub> , 2=0.8Vrms
Voltage gain difference	ΔG <sub>V</sub>	−2.1	−0.3	1.2	dB	G <sub>V1</sub> (f=1kHz) −G <sub>V1</sub> (f=10kHz)
Total harmonic distortion 1	THD <sub>1</sub>	—	0.05	0.2	%	V <sub>IN1</sub> , 2=0.8Vrms
Maximum output voltage 1	V <sub>OM1</sub>	0.8	1.1	—	Vrms	THD=0.2%
Output noise voltage 1	V <sub>NO1</sub>	—	−96	−90	dBV	R <sub>g</sub> =0
Channel separation 1	CS <sub>1</sub>	68	78	—	dB	V <sub>IN1</sub> , 2=0.8Vrms, R <sub>g</sub> =0
Ripple rejection 1	RR <sub>1</sub>	37	47	—	dB	V <sub>RR</sub> =−20dBV, f <sub>RR</sub> =1kHz, R <sub>g</sub> =0
〈Line-out〉 (BA3579FS)						
Voltage gain	G <sub>V1</sub>	3.6	5.6	7.6	dB	V <sub>IN1</sub> , 2=0.4Vrms
Voltage gain difference	ΔG <sub>V</sub>	−2.1	−0.3	1.2	dB	G <sub>V1</sub> (f=1kHz) −G <sub>V1</sub> (f=10kHz)
Total harmonic distortion 1	THD <sub>1</sub>	—	0.05	0.2	%	V <sub>IN1</sub> , 2=0.4Vrms
Maximum output voltage 1	V <sub>OM1</sub>	0.8	1.1	—	Vrms	THD=0.2%
Output noise voltage 1	V <sub>NO1</sub>	—	−96	−90	dBV	R <sub>g</sub> =0
Channel separation 1	CS <sub>1</sub>	68	78	—	dB	V <sub>IN1</sub> , 2=0.4Vrms, R <sub>g</sub> =0
Ripple rejection 1	RR <sub>1</sub>	37	47	—	dB	V <sub>RR</sub> =−20dBV, f <sub>RR</sub> =1kHz, R <sub>g</sub> =0
〈Headphone out〉						
Voltage gain 2	G <sub>V2</sub>	10.2	12.2	14.2	dB	V <sub>IN3</sub> , 4=−20dBV
Total harmonic distortion 2	THD <sub>2</sub>	—	0.1	0.5	%	V <sub>IN3</sub> , 4=−20dBV
Rated output	P <sub>O</sub>	20	32	—	mW	THD=10%
Output noise voltage 2	V <sub>NO2</sub>	—	−90	−84	dBV	R <sub>g</sub> =0
Channel separation 2	CS <sub>2</sub>	59	69	—	dB	V <sub>IN3</sub> , 4=−20dBV, R <sub>g</sub> =0
Channel separation 3	CS <sub>3</sub>	11	14	—	dB	V <sub>IN3</sub> , 4=−20dBV, R <sub>g</sub> =0, BB ON
Channel separation 4	CS <sub>4</sub>	25	35	—	dB	V <sub>IN3</sub> , 4=−20dBV, R <sub>g</sub> =10kΩ
Mute attenuation	ATT <sub>M</sub>	59	69	—	dB	V <sub>IN3</sub> , 4=−20dBV, MUTE ON
Bass boost	BB	6.1	9.1	12.1	dB	V <sub>IN3</sub> , 4=−30dBV, f=100Hz, BB ON
Ripple rejection 2	RR <sub>2</sub>	26	36	—	dB	V <sub>RR</sub> =−20dBV, f <sub>RR</sub> =1kHz, R <sub>g</sub> =0

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● Measurement circuits

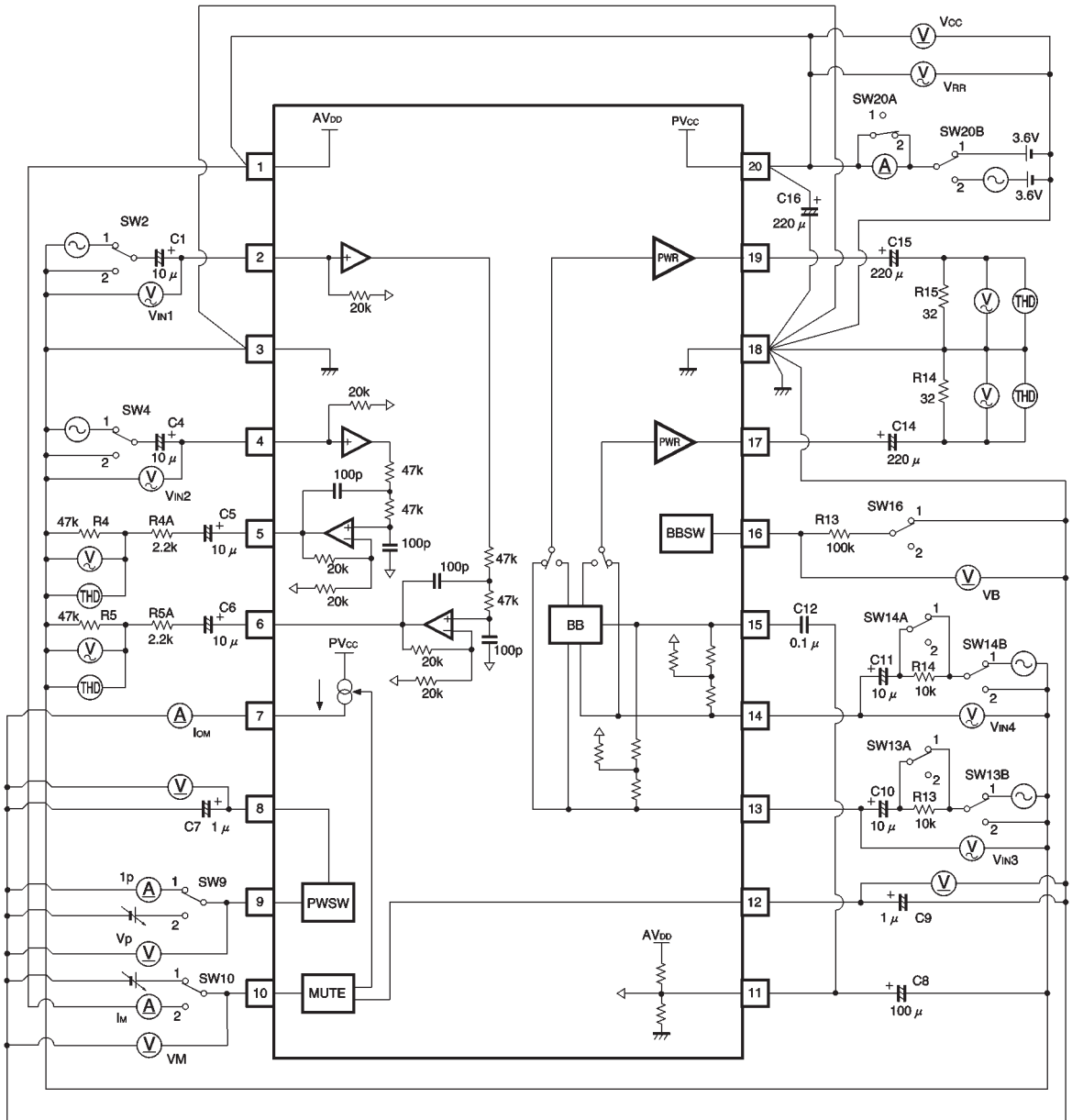
BA3578FS



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

Fig.1

BA3579FS



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

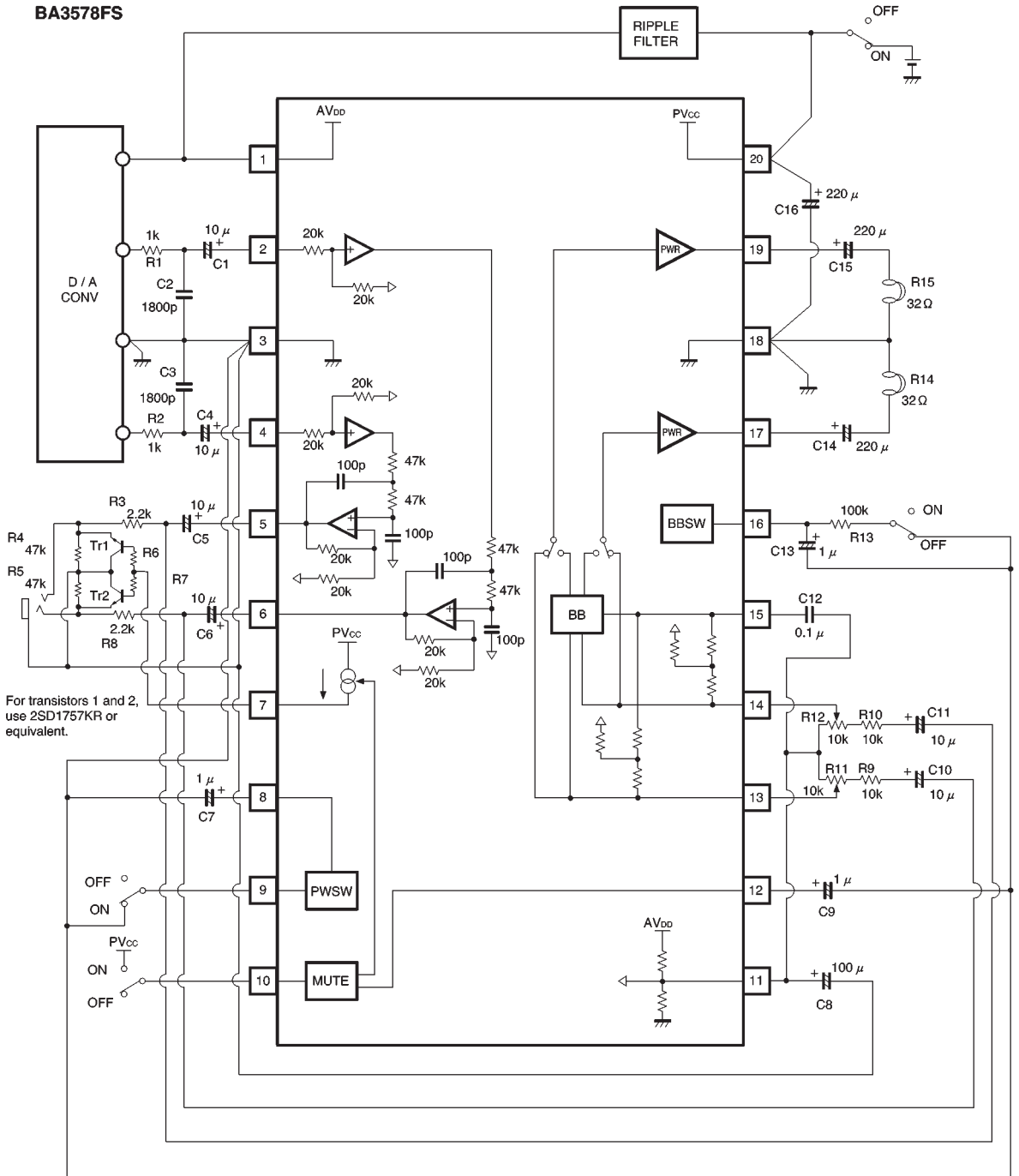
Fig.2

## Measurement conditions

Parameter	Symbol	SW2	SW4	SW9	SW10	SW13 A	SW13 B	SW14 A	SW14 B	SW16	SW20 A	SW20 B
Circuit current	I <sub>CC</sub>	2	2	1	1	1	2	1	2	1	1	1
Power ON voltage	V <sub>P</sub>	↓	↓	2	↓	↓	↓	↓	↓	↓	2	↓
Power ON pin current	I <sub>P</sub>	↓	↓	1	↓	↓	↓	↓	↓	↓	↓	↓
Mute ON voltage	V <sub>M</sub>	↓	↓	↓	2	↓	↓	↓	↓	↓	↓	↓
Mute pin current	I <sub>M</sub>	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
Mute output current	I <sub>OM</sub>	↓	↓	↓	1	↓	↓	↓	↓	↓	↓	↓
Bass boost OFF voltage	V <sub>B</sub>	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
〈Line-out〉												
Voltage gain 1	G <sub>V1</sub>	1	1	↓	↓	↓	2	↓	2	↓	↓	↓
Voltage gain difference	ΔG <sub>V</sub>	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
Total harmonic distortion 1	THD <sub>1</sub>	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
Maximum output voltage 1	V <sub>OM1</sub>	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
Output noise voltage 1	V <sub>NO1</sub>	2	2	↓	↓	↓	↓	↓	↓	↓	↓	↓
Channel separation 1	CS <sub>1</sub>	1 / 2	2 / 1	↓	↓	↓	↓	↓	↓	↓	↓	↓
Ripple rejection 1	RR <sub>1</sub>	2	2	↓	↓	↓	↓	↓	↓	↓	↓	2
〈Headphone out〉												
Voltage gain 2	G <sub>V2</sub>	2	2	↓	↓	↓	↓	↓	↓	↓	↓	1
Total harmonic distortion 2	THD <sub>2</sub>	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
Rated output	P <sub>O</sub>	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
Output noise voltage 2	V <sub>NO2</sub>	↓	↓	↓	↓	↓	2	↓	2	↓	↓	↓
Channel separation 2	CS <sub>2</sub>	↓	↓	↓	↓	↓	1 / 2	↓	2 / 1	↓	↓	↓
Channel separation 3	CS <sub>3</sub>	↓	↓	↓	↓	↓	↓	↓	↓	2	↓	↓
Channel separation 4	CS <sub>4</sub>	↓	↓	↓	↓	2 / 1	↓	1 / 2	↓	1	↓	↓
Mute attenuation	ATT <sub>M</sub>	↓	↓	↓	2	1	1	1	1	1	↓	↓
Bass boost	BB	↓	↓	↓	↓	↓	↓	↓	↓	2	↓	↓
Ripple rejection 2	RR <sub>2</sub>	1	↓	↓	↓	↓	2	↓	2	1	↓	2

● Application examples

BA3578FS

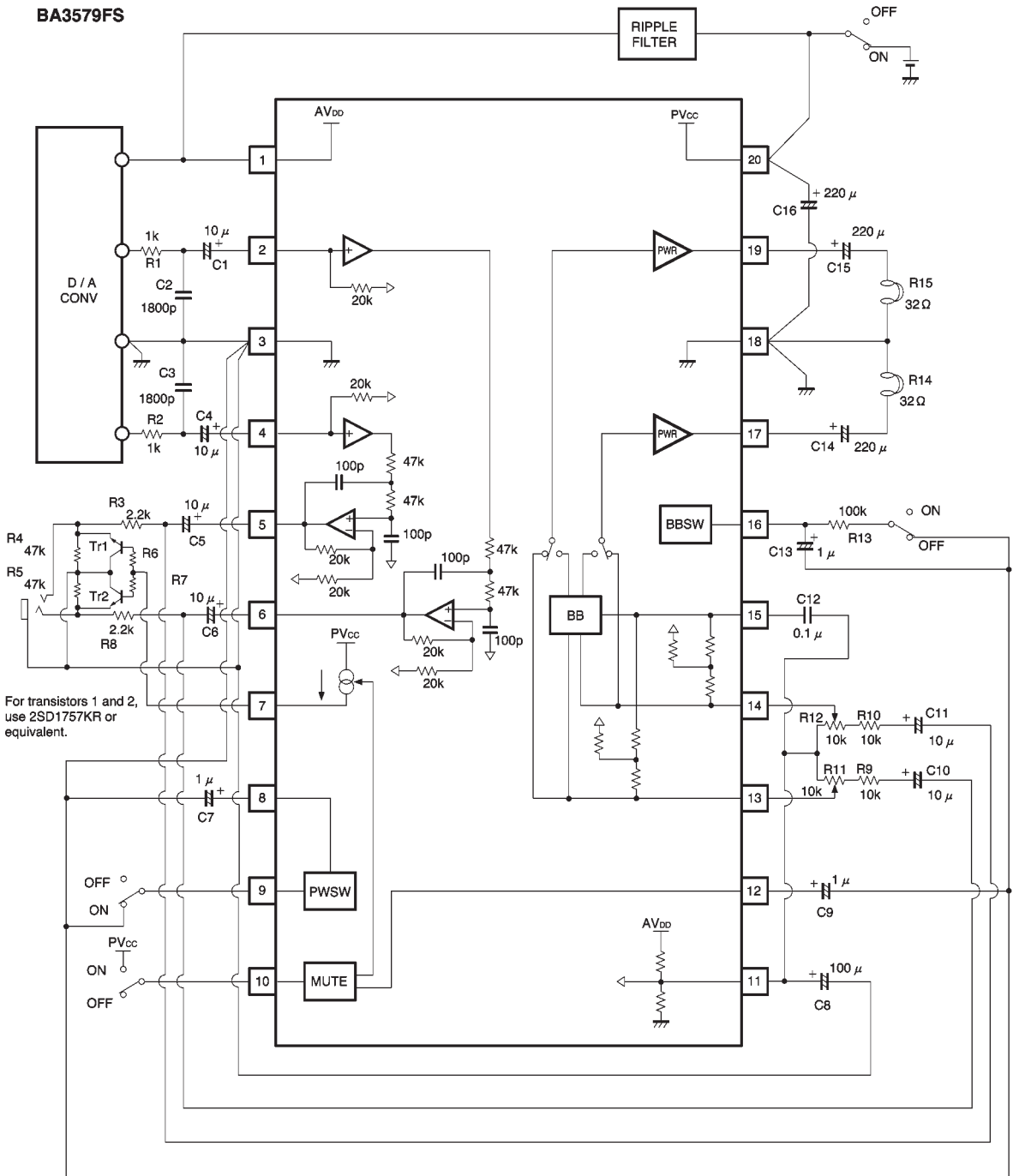


For transistors 1 and 2, use 2SD1757KR or equivalent.

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

Fig.3





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

Fig.4

● Circuit operation

(1) By operating the BA3578FS and BA3579FS according to the timing chart shown in Fig. 5, it is possible to suppress generation of “pop” noise in the headphone output.

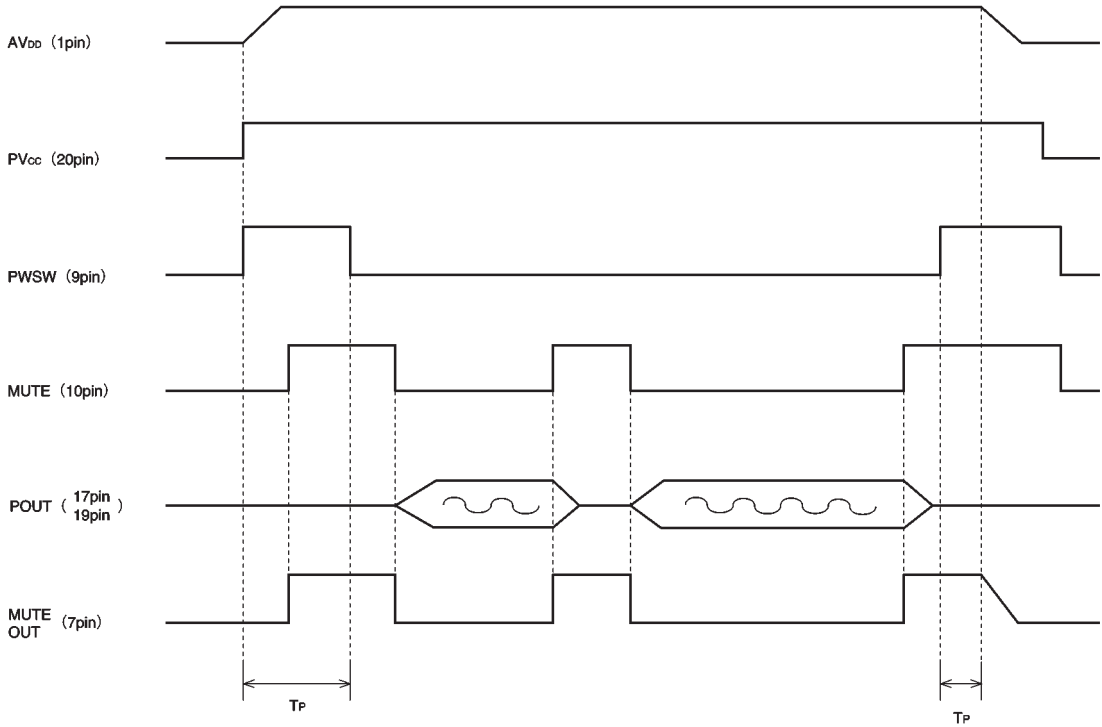


Fig.5 Timing chart

$T_P$  100msec.

(2) The voltage of the BIAS pin (pin 11) for the BA3578FS and BA3579FS is the voltage divided from the AVDD pin (pin 1). There is no current carrying capacity, so do not use it as an operating point for external circuits.

●Electrical characteristic curves

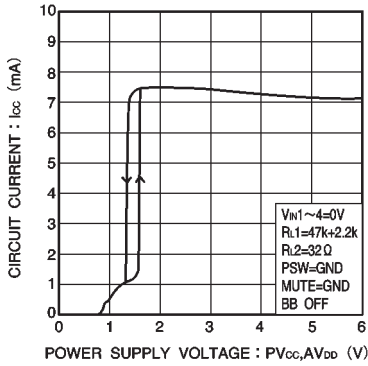


Fig.6 Circuit current vs. power supply voltage

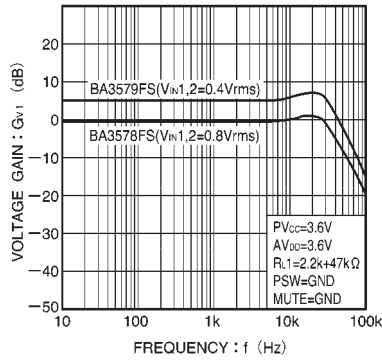


Fig.7 Voltage gain vs. power supply voltage (line-out)

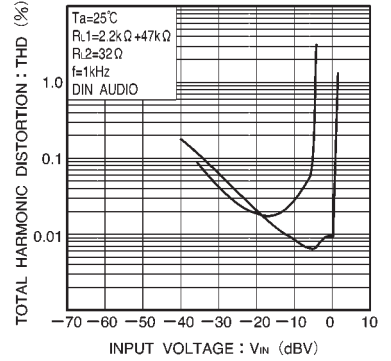


Fig.8 Total harmonic distortion vs. input voltage (line-out)

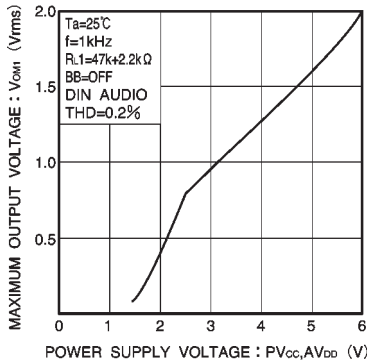


Fig.9 Maximum output voltage vs. power supply voltage (line-out)

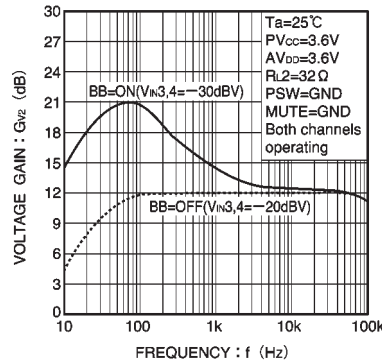


Fig.10 Voltage gain vs. frequency characteristics (headphone-out)

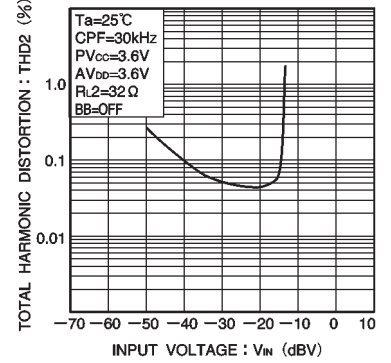


Fig.11 Total harmonic distortion vs. input voltage (headphone-out)

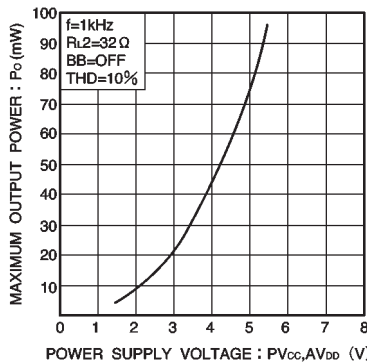


Fig.12 Maximum output voltage vs. power supply voltage (headphone-out)

●External dimensions (Unit: mm)

