

# Pre / power amplifier for 1.5V headphone stereos

## BA3632K

The BA3632K is a dual-channel pre / power system IC designed for 1.5V headphone stereos. There is no need for DC/DC conversion, and the system can operate off a single battery. The IC draws low current ( $I_{CC} = 2.6\text{mA}$ ) to allow long set life.

### ●Applications

1.5V headphone stereos.

### ●Features

- 1) Dual pre-amplifiers with auto reverse compatibility.
- 2) Dual power amplifiers.
- 3) Bass boost circuit (variable bass boost).
- 4) AMS circuit (on chip comparator).
- 5) Ripple filter.
- 6) Low power consumption ( $I_{CC} = 6.8\text{mA}$ ,  $0.5\text{W} \times 2\text{ch}$ ,  $R_L = 32\Omega$ ).

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

Parameter	Symbol	Limits	Unit
Power supply voltage	$V_{CC}$	3.0	V
Power dissipation	$P_d$	400 <sup>*1</sup>	mW
Operating temperature	$T_{opr}$	$-10 \sim +60$	$^\circ\text{C}$
Storage temperature	$T_{stg}$	$-55 \sim +125$	$^\circ\text{C}$

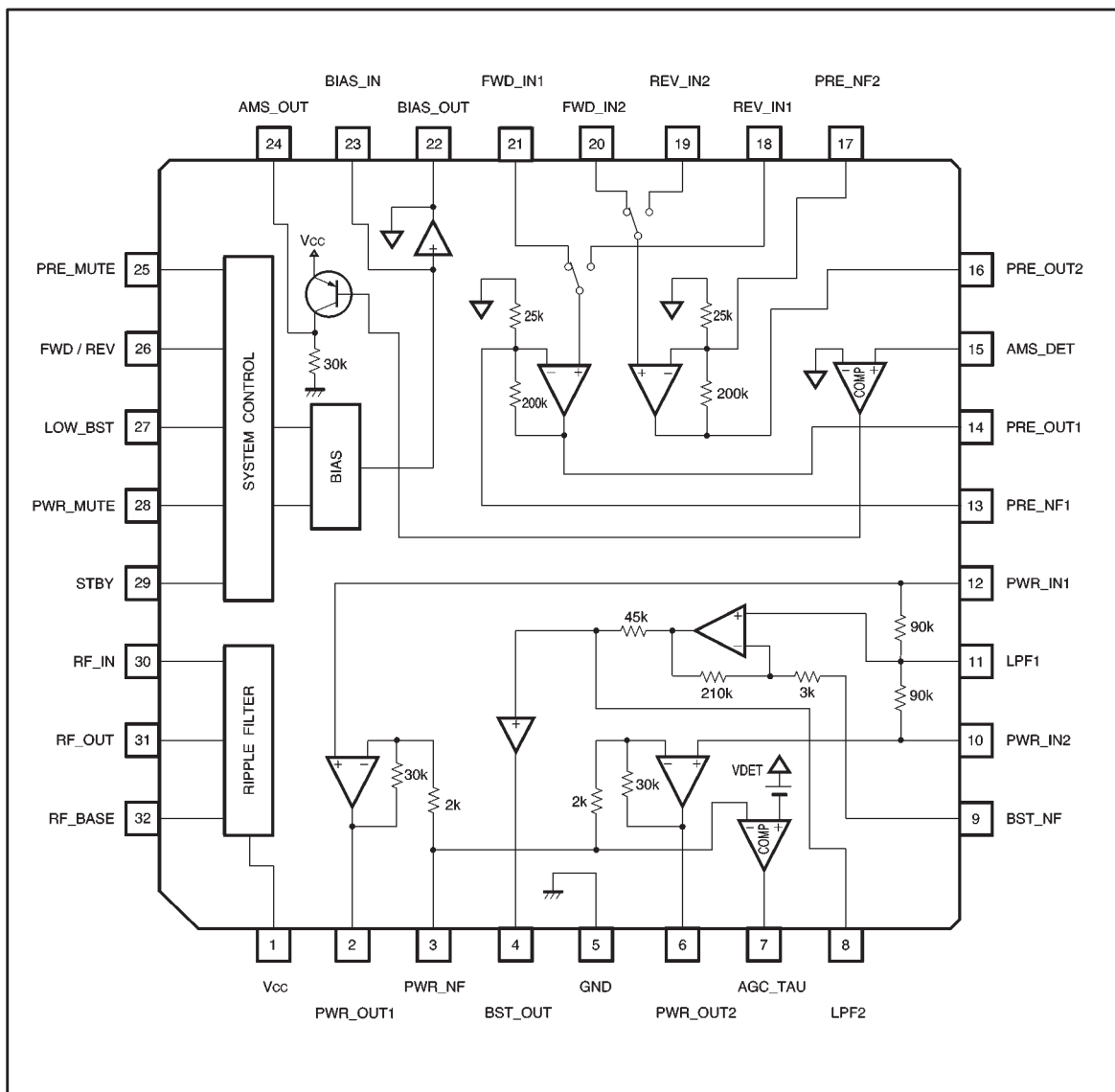
\*1 Reduced by 4.0mW for each increase in  $T_a$  of  $1^\circ\text{C}$  over  $25^\circ\text{C}$ .

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


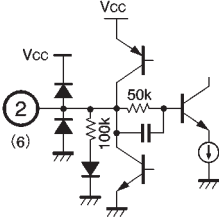
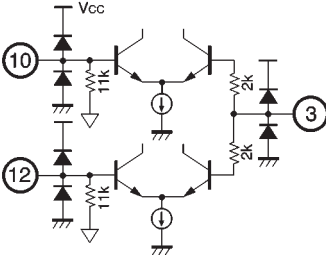
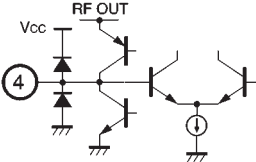

Parameter	Symbol	Limits	Unit
Power supply voltage	$V_{CC}$	0.95 (0.98) $\sim$ 2.2*	V

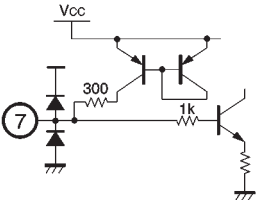
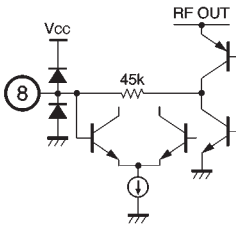
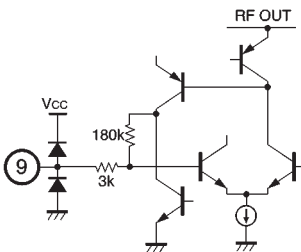
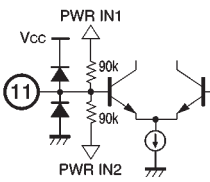
\* The range  $V_{CC} = 0.95\text{V}$  to  $0.98\text{V}$  is the operating range for which oscillation will not occur.  
The ripple rejection for the ripple filter is stipulated for  $V_{CC} = 1.1\text{V}$ .

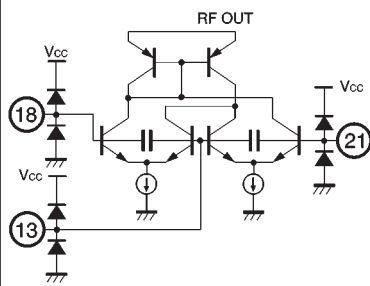
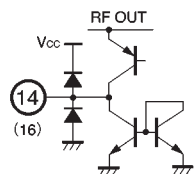
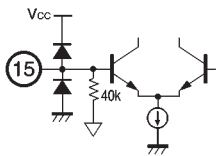
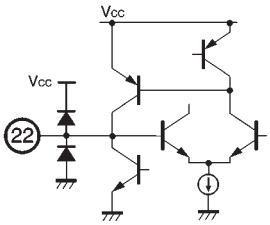
● Block diagram

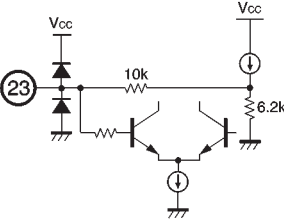
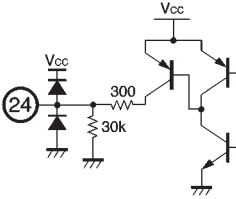
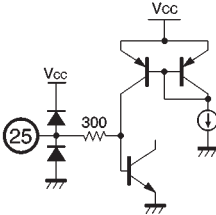
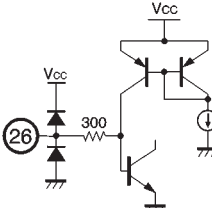


●Pin descriptions

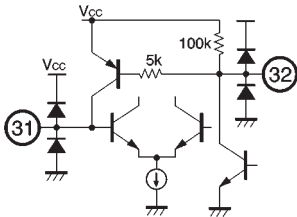
Pin No.	Pin name	I / O	Pin voltage	Internal equivalent circuit	Function
1	Vcc	I	1.2V		+B Power supply
2	PWR_OUT1	O	0.76V		Power amplifier output pin 1 Power amplifier output pin 2
6	PWR_OUT2	O	0.76V		
3	PWR_NF	I	0.76V		Power amplifier NF
10	PWR_IN2	I	0.76V		Power amplifier input pin 2
12	PWR_IN1	I	0.76V		Power amplifier input pin 1
4	BST_OUT	O	0.76V		Boost amplifier output
5	GND	I	GND		Ground

Pin No.	Pin name	I / O	Pin voltage	Internal equivalent circuit	Function
7	AGC_TAU	O	—		AGC time constant setting pin for boost
8	LPF2	O	0.76V		Low-pass filter pin 2
9	BST_NF	I	0.76V		Boost amplifier NF
11	LPF1	O	0.76V		Low pass filter pin 1

Pin No.	Pin name	I / O	Pin voltage	Internal equivalent circuit	Function
13	PRE_NF1	I	0.74V		Pre-amplifier NF pin 1
17	PRE_NF2	I	0.74V		Pre-amplifier NF pin 2
18	REV_IN1	I	0.76V		Pre-amplifier REV input pin 1
19	REV_IN2	I	0.76V		Pre-amplifier REV input pin 2
21	FWD_IN1	I	0.76V		Pre-amplifier FWD input pin 1
20	FWD_IN2	I	0.76V		Pre-amplifier FWD input pin 2
14	PRE_OUT1	O	0.5V		Pre-amplifier output pin 1
16	PRE_OUT2	O	0.5V		Pre-amplifier output pin 2
15	AMS_DET	I	0.76V		AMS comparator input
22	BIAS_OUT	O	0.76V		Bias output

Pin No.	Pin name	I / O	Pin voltage	Internal equivalent circuit	Function
23	BIAS_IN	O	0.76V		Bias reference output
24	AMS_OUT	O	—		AMS detector output
25	PRE_MUTE	I	—		Pre-mute control
26	FWD / REV	I	—		Pre-amplifier input switch

Pin No.	Pin name	I / O	Pin voltage	Internal equivalent circuit	Function
27	LOW_BST	I	—		Boost ON / OFF control
28	PWR_MUTE	I	—		Power mute control
29	STBY	I	Vcc When open		Standby control
30	RF_IN	O	1.13V		Ripple filter reference output

Pin No.	Pin name	I / O	Pin voltage	Internal equivalent circuit	Function
31	RF_OUT	O	1.13V		Ripple filter output
32	RF_BASE	O	0.65V		Ripple filter external transistor base



- Electrical characteristics (unless otherwise noted, Ta = 25°C, V<sub>CC</sub> = 1.2V, f = 1kHz, R<sub>L</sub> = 10kΩ (pre-amplifier), R<sub>L</sub> = 32Ω (power amplifier), L.BOOST OFF, 0dBm = 0.775Vrms)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Coniditions
〈Pre+power amplifier〉						
Voltage gain	GVTTL	54	57	60	dB	V <sub>O</sub> =−20dBm
Circuit current 1	I <sub>CC1</sub>	—	2.6	4.2	mA	V <sub>IN</sub> =0, R <sub>g</sub> =2.2kΩ
Circuit current 2	I <sub>CC2</sub>	—	2.6	4.1	mA	L.BOOST ON, V <sub>IN</sub> =0, R <sub>g</sub> =2.2kΩ
Circuit current 3	I <sub>CC3</sub>	—	6.8	10.3	mA	P <sub>OUT</sub> =0.5mW×2ch, R <sub>g</sub> =32Ω
Circuit current 4	I <sub>CC4</sub>	—	5	20	μA	STBY OFF
〈Pre-amplifier〉						
Open-circuit voltage gain	G <sub>VO</sub>	61	73	—	dB	V <sub>O</sub> =−20dBm
Closed-circuit voltage gain	G <sub>VC</sub>	33.5	35	36.5	dB	V <sub>O</sub> =−20dBm
Maximum output voltage	V <sub>OM</sub>	120	210	—	mV	THD=1%, DIN AUDIO
Total harmonic distortion	THD	—	0.2	0.6	%	V <sub>O</sub> =−20dBm, G <sub>VC</sub> =35dB (NAB), DIN AUDIO
Input conversion noise voltage	V <sub>NIN</sub>	—	1.5	3	μV	R <sub>g</sub> =2.2kΩ, G <sub>VC</sub> =35dB (NAB), DIN AUDIO
Channel separation	CS	37	46	—	dB	Single-channel input, R <sub>g</sub> =2.2kΩ V <sub>O</sub> =−20dBm
FWD / REV REV crosstalk	CT <sub>F-R</sub>	51	59	—	dB	Single-channel input, R <sub>g</sub> =2.2kΩ V <sub>O</sub> =−20dBm
Ripple rejection	RR	43	53	—	dB	R <sub>g</sub> =2.2kΩ, V <sub>RR</sub> =−30dBm, f <sub>RR</sub> =100Hz I <sub>RFO</sub> =25mA, BPF : 100Hz 1/4 OCT
Mute output voltage	V <sub>MUTE</sub>	—	−110	−90	dBm	V <sub>IN</sub> =−40dBm, PRE MUTE ON
〈Bass+power amplifier〉						
Voltage gain 1	G <sub>V1</sub>	21.5	23.5	25.5	dB	V <sub>O</sub> =−20dBm
Voltage gain 2	G <sub>V2</sub>	21.7	23.7	25.7	dB	L.BOOST ON, V <sub>O</sub> =−20dBm
Voltage gain 3	G <sub>V3</sub>	31	35	39	dB	L.BOOST ON, f=100Hz, V <sub>O</sub> =−20dBm
Rated output power	P <sub>OUT</sub>	5	9	—	mW	THD=10%, DIN AUDIO, R <sub>L</sub> =16Ω
Total harmonic distortion	THD	—	0.35	1.3	%	P <sub>OUT</sub> =1mW, DIN AUDIO
Channel separation 1	CS1	33	40	—	dB	Single-channel input, R <sub>g</sub> =0 V <sub>O</sub> =−20dBm
Channel separation 2	CS2	35	45	—	dB	Single-channel input, L.BOOST ON, R <sub>g</sub> =0, V <sub>O</sub> =−20dBm
Output noise voltage 1	V <sub>NO1</sub>	—	24	40	μV	R <sub>g</sub> =0
Output noise voltage 2	V <sub>NO2</sub>	—	48	80	μV	L.BOOST ON, R <sub>g</sub> =0
Ripple rejection 1	RR1	64	74	—	dB	R <sub>g</sub> =0, V <sub>RR</sub> =−30dBm, f <sub>RR</sub> =100Hz I <sub>RFO</sub> =25mA, BPF : 100Hz 1/4 OCT
Ripple rejection 2	RR2	42	51	—	dB	L.BOOST ON R <sub>g</sub> =0, V <sub>RR</sub> =−30dBm, f <sub>RR</sub> =100Hz I <sub>RFO</sub> =25mA, BPF : 100Hz 1/4 OCT
Input resistance	R <sub>IN</sub>	7.5	10	13	kΩ	—
Channel balance	CB	−1.5	0	1.5	dB	V <sub>O</sub> =−20dBm
Mute output voltage	V <sub>MUTE</sub>	—	−110	−90	dBm	V <sub>IN</sub> =−30dBm
AGC level	V <sub>AGC</sub>	−14.1	−12.5	−10.9	dBm	V <sub>IN</sub> =43dBm, f=100Hz, R <sub>L</sub> =16Ω AGC level measured at the end of the 16Ω resistor

Parameter	Symbol	Min.	Typ.	Max.	Unit	Coniditions
〈Ripple filter block〉						
Ripple rejection	RR	33	39	—	dB	V <sub>CC</sub> =1.1V, V <sub>RR</sub> =−30dBm, f <sub>RR</sub> =100Hz I <sub>RFO</sub> =25mA, BPF : 100Hz 1/4 OCT
DC output voltage	V <sub>RF</sub>	0.89	0.94	—	V	V <sub>CC</sub> =1.0V, I <sub>RFO</sub> =25mA
〈Bias block〉						
DC output voltage	V <sub>BIAS</sub>	0.68	0.76	0.83	V	V <sub>CC</sub> =1.0V
〈AMS block〉						
Song detect level 1	VBS	−23.6	−22	−20.4	dBV	POWER MUTE ON When V <sub>24PIN</sub> =0.6V <sub>P-O</sub>
Song detect level 2	VMS	−39.6	−38	−36.4	dBV	POWER MUTE OFF When V <sub>24PIN</sub> =0.6V <sub>P-O</sub>
〈AMS-Ta characteristics〉						
Ambient temperature	Ta	−10	+25	+50	℃	—
Song detect level 3	Δ VBS	−1.1	0	+0.6	dB	POWER MUTE ON When V <sub>24PIN</sub> =0.6V <sub>P-O</sub>
Song detect level 4	Δ VMS	−1.1	0	+0.6	dB	POWER MUTE OFF When V <sub>24PIN</sub> =0.6V <sub>P-O</sub>
〈Control block〉						
Standby on voltage	V <sub>STON</sub>	—	—	0.4	V	“L” : POWER ON
Standby off voltage	V <sub>STOFF</sub>	0.9	—	—	V	“H” / OPEN : POWER OFF
Standby pin current	I <sub>STBY</sub>	—	23	45	μA	V <sub>29PIN</sub> =0V
Power mute on threshold	V <sub>MTON</sub>	—	—	0.05	V	“L” : POWER MUTE ON
Power mute off threshold	V <sub>MTOFF</sub>	0.3	—	—	V	“H” / OPEN : POWER MUTE OFF
Power mute pin current	I <sub>SW28</sub>	—	0.3	0.9	μA	V <sub>28PIN</sub> =0.1V
FWD/REV low threshold	V <sub>TH26</sub>	—	—	0.4	V	“L” : REV
FWD/REV pin current	I <sub>SW26</sub>	—	3	6	μA	V <sub>26PIN</sub> =0.2V
Low boost off threshold	V <sub>LBOFF</sub>	—	—	0.1	V	“L” : L.BOOST OFF
Low boost on threshold	V <sub>LBON</sub>	0.4	—	—	V	“H” / OPEN : L.BOOST ON
Low boost pin current	I <sub>SW27</sub>	—	0.3	0.9	μA	V <sub>27PIN</sub> =0.1V
Pre-mute low threshold	V <sub>TH25</sub>	—	—	0.4	V	“L” : PRE MUTE OFF
Pre-mute pin current	I <sub>SW25</sub>	—	3	6	μA	V <sub>25PIN</sub> =0.2V

○Not designed for radiation resistance.

## ● Measurement circuit

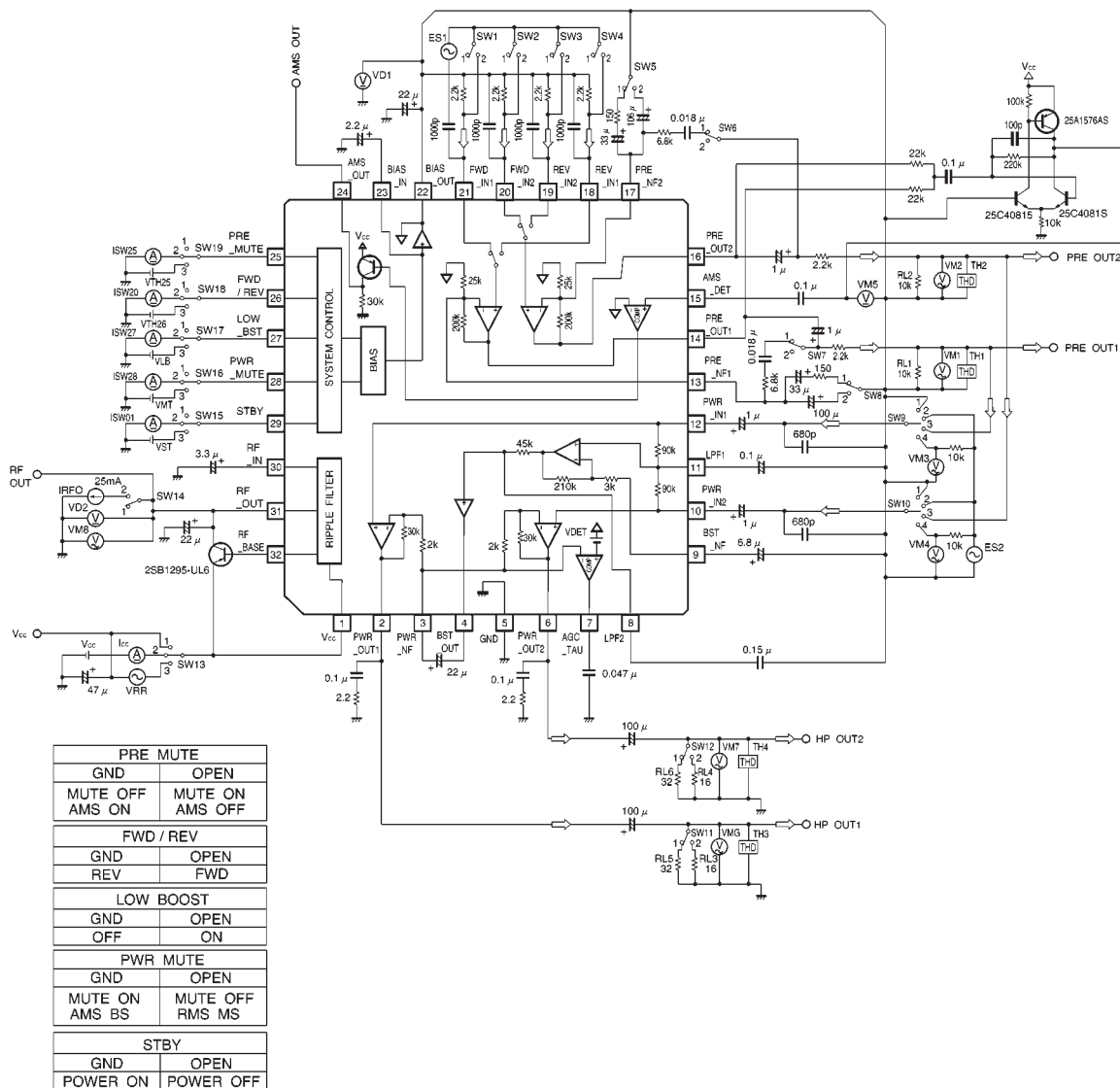


Fig.1

## ● Measurement circuit switching table

Parameter	Symbol	SW No.																		
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
〈Pre+power amplifier〉																				
Voltage gain	GV <sub>TTL</sub>	2/1	2/1	1/2	1/2	1	1	1	1	3	3	1	1	1	1	2	1	2	1/2	2
Circuit current 1	I <sub>CC1</sub>	1	1	1	1	↓	↓	↓	↓	1	1	↓	↓	2	↓	↓	↓	↓	2	↓
Circuit current 2	I <sub>CC2</sub>	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	1	↓	↓
Circuit current 3	I <sub>CC3</sub>	2/1	2/1	1/2	1/2	↓	↓	↓	↓	3	3	↓	↓	↓	↓	↓	↓	2	1/2	↓
Circuit current 4	I <sub>CC4</sub>	1	1	1	1	↓	↓	↓	↓	1	1	↓	↓	↓	↓	1	↓	↓	2	↓
〈Pre+amplifier〉																				
Open-circuit voltage gain	G <sub>VO</sub>	2/1	2/1	2/1	2/1	2	2	2	2	1	1	1	1	1	1	2	1	2	1/2	2
Closed-circuit voltage gain	G <sub>VC</sub>	↓	↓	↓	↓	1	1	1	1	↓	↓	↓	↓	↓	↓	↓	↓	1	↓	↓
Maximum output voltage	V <sub>OM</sub>	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
Total harmonic distortion	THD	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
Input conversion noise voltage	V <sub>NIN</sub>	1	1	1	1	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
Channel separation	CS	2/1	1/2	1	1	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	1	↓
		1	1	2/1	1/2	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	2	↓
FWD / REV REV crosstalk	CT <sub>F-R</sub>	2/1	2/1	1/2	1/2	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	2/1	↓
Ripple rejection	RR	1	1	1	1	↓	↓	↓	↓	↓	↓	↓	↓	3	2	↓	↓	↓	1/2	↓
Mute output voltage	V <sub>MUTE</sub>	2/1	2/1	1/2	1/2	↓	↓	↓	↓	↓	↓	↓	↓	1	1	↓	↓	↓	↓	1
〈Bass+power amplifier〉																				
Voltage gain 1	G <sub>V1</sub>	1	1	1	1	1	1	1	1	2	2	1	1	1	1	2	1	2	2	2
Voltage gain 2	G <sub>V2</sub>	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	1	↓	↓
Voltage gain 3	G <sub>V3</sub>	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
Rated output power	P <sub>OUT</sub>	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	2	2	↓	↓	↓	↓	2	↓	↓
Total harmonic distortion	THD	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	1	1	↓	↓	↓	↓	↓	↓	↓
Channel separation 1	CS1	↓	↓	↓	↓	↓	↓	↓	↓	2/1	1/2	↓	↓	↓	↓	↓	↓	↓	↓	↓
Channel separation 2	CS2	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	1	↓	↓
Output noise voltage 1	V <sub>NO1</sub>	↓	↓	↓	↓	↓	↓	↓	↓	1	1	↓	↓	↓	↓	↓	↓	2	↓	↓
Output noise voltage 2	V <sub>NO2</sub>	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	1	↓	↓
Ripple rejection 1	RR1	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	3	2	↓	↓	2	↓	↓
Ripple rejection 2	RR2	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	1	↓	↓
Input resistance	R <sub>IN</sub>	↓	↓	↓	↓	↓	↓	↓	↓	4	4	↓	↓	↓	↓	↓	↓	2	↓	↓
Channel balance	CB	↓	↓	↓	↓	↓	↓	↓	↓	2	2	↓	↓	↓	↓	↓	↓	↓	↓	↓
Mute output voltage	V <sub>MUTE</sub>	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	2	↓	↓	↓
AGC level	V <sub>AGC</sub>	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	2	2	↓	↓	↓	1	1	↓	↓
〈Ripple filter block〉																				
Ripple rejection	RR	1	1	1	1	1	1	1	1	1	1	1	1	3	2	2	1	2	2	2
DC output voltage	V <sub>RF</sub>	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	1	1	↓	↓	↓	↓	↓
〈Bias block〉																				
DC output voltage	V <sub>BIAS</sub>	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	2	2	2
〈AMS block〉																				
Song detect level 1	V <sub>BS</sub>	2	2	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2
Song detect level 2	V <sub>MS</sub>	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓

Parameter	Symbol	SW No.																		
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
〈Control block〉																				
Standby on/off voltage	V <sub>ST</sub>	1	1	1	1	1	1	1	1	1	1	1	1	1	2	3	1	2	2	2
Standby pin current	I <sub>STBY</sub>	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	1	2	↓	↓	↓	↓
Power mute on/off threshold	V <sub>MT</sub>	↓	↓	↓	↓	↓	↓	↓	↓	2	2	↓	↓	↓	↓	↓	3	↓	↓	↓
Power mute pin current	I <sub>SW28</sub>	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	2	↓	↓	↓
FWD/REV low threshold	V <sub>TM26</sub>	2/1	2/1	1/2	1/2	↓	↓	↓	↓	1	1	↓	↓	↓	↓	↓	1	↓	3	↓
FWD/REV pin current	I <sub>SW26</sub>	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	2	↓
Low boost on/off threshold	V <sub>LB</sub>	1	1	1	1	↓	↓	↓	↓	2	2	↓	↓	↓	↓	↓	↓	3	↓	↓
Low boost pin current	I <sub>SW27</sub>	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	2	↓	↓
Pre-mute low threshold	V <sub>TH25</sub>	2/1	2/1	1/2	1/2	↓	↓	↓	↓	1	1	↓	↓	↓	↓	↓	↓	↓	1/2	3
Pre-mute pin current	I <sub>SW25</sub>	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	2

## ●Application example

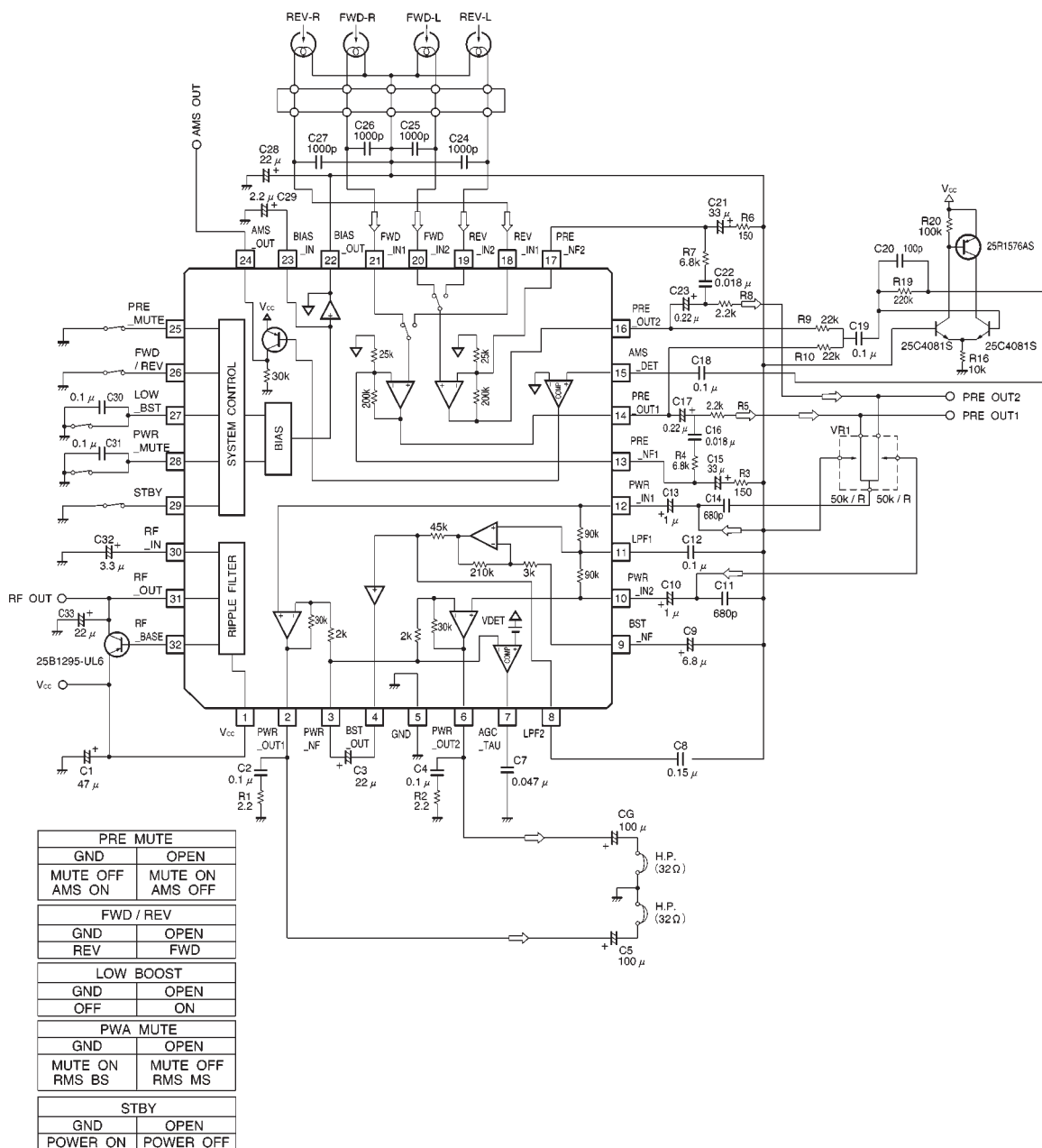


Fig.2

● Electrical characteristics curves

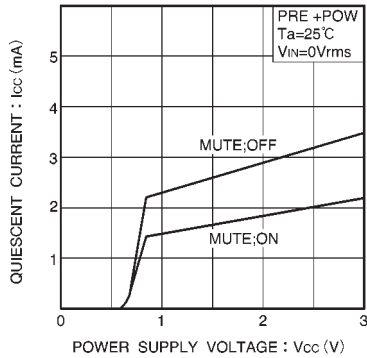


Fig.3 Quiescent current vs. power supply voltage

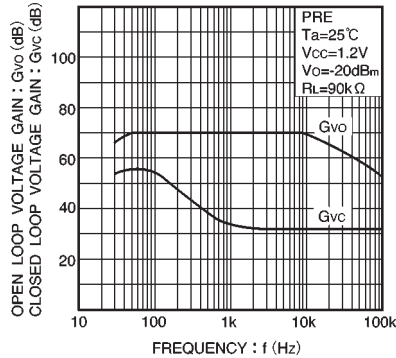


Fig.4 Voltage gain vs. frequency

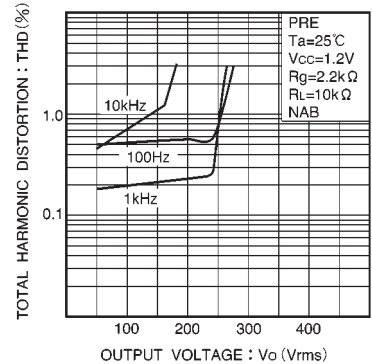


Fig.5 Total harmonic distortion vs. output voltage

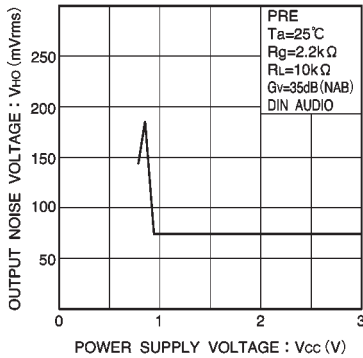


Fig.6 Output noise voltage gain vs. power supply voltage

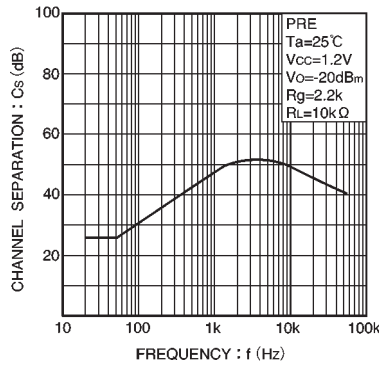


Fig.7 Channel separation vs. frequency

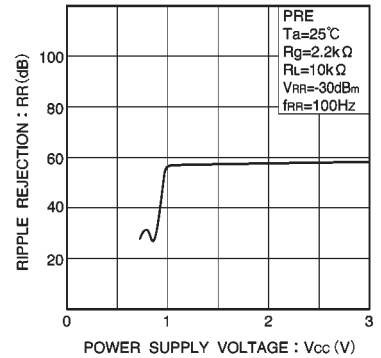


Fig.8 Ripple rejection vs. power supply voltage

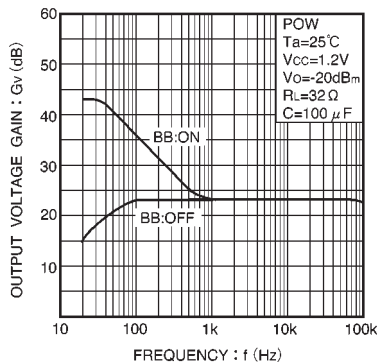


Fig.9 Voltage gain vs. frequency

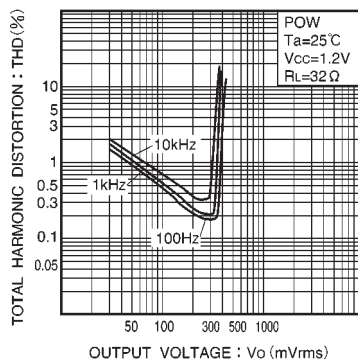


Fig.10 Total harmonic distortion vs. output voltage

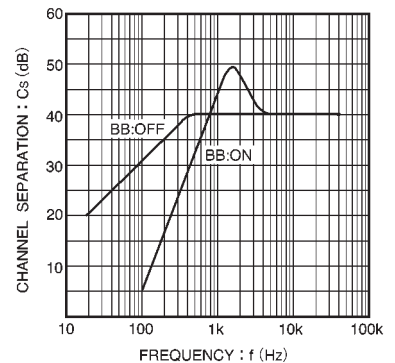


Fig.11 Channel separation vs. frequency

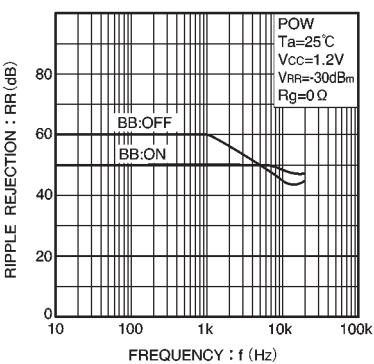


Fig.12 Ripple rejection vs. frequency

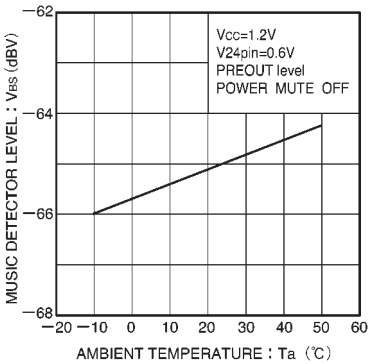


Fig.13 Song detect 3 vs. temperature

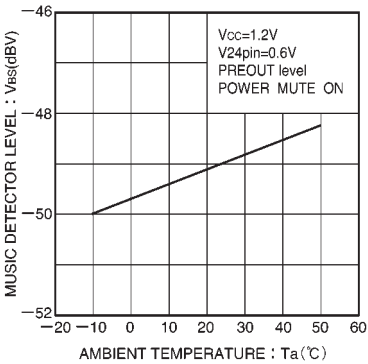


Fig.14 Song detect level vs. temperature

●External dimensions (Unit:s mm)

