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} = 2.6mA) 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} = 6.8mA, 0.5W × 2ch, R_L = 32Ω).

●Absolute maximum ratings (Ta = 25°C)

Parameter	Symbol	Limits	Unit
Power supply voltage	V_{CC}	3.0	V
Power dissipation	Pd	400*1	mW
Operating temperature	Topr	−10～+60	℃
Storage temperature	Tstg	−55～+125	℃

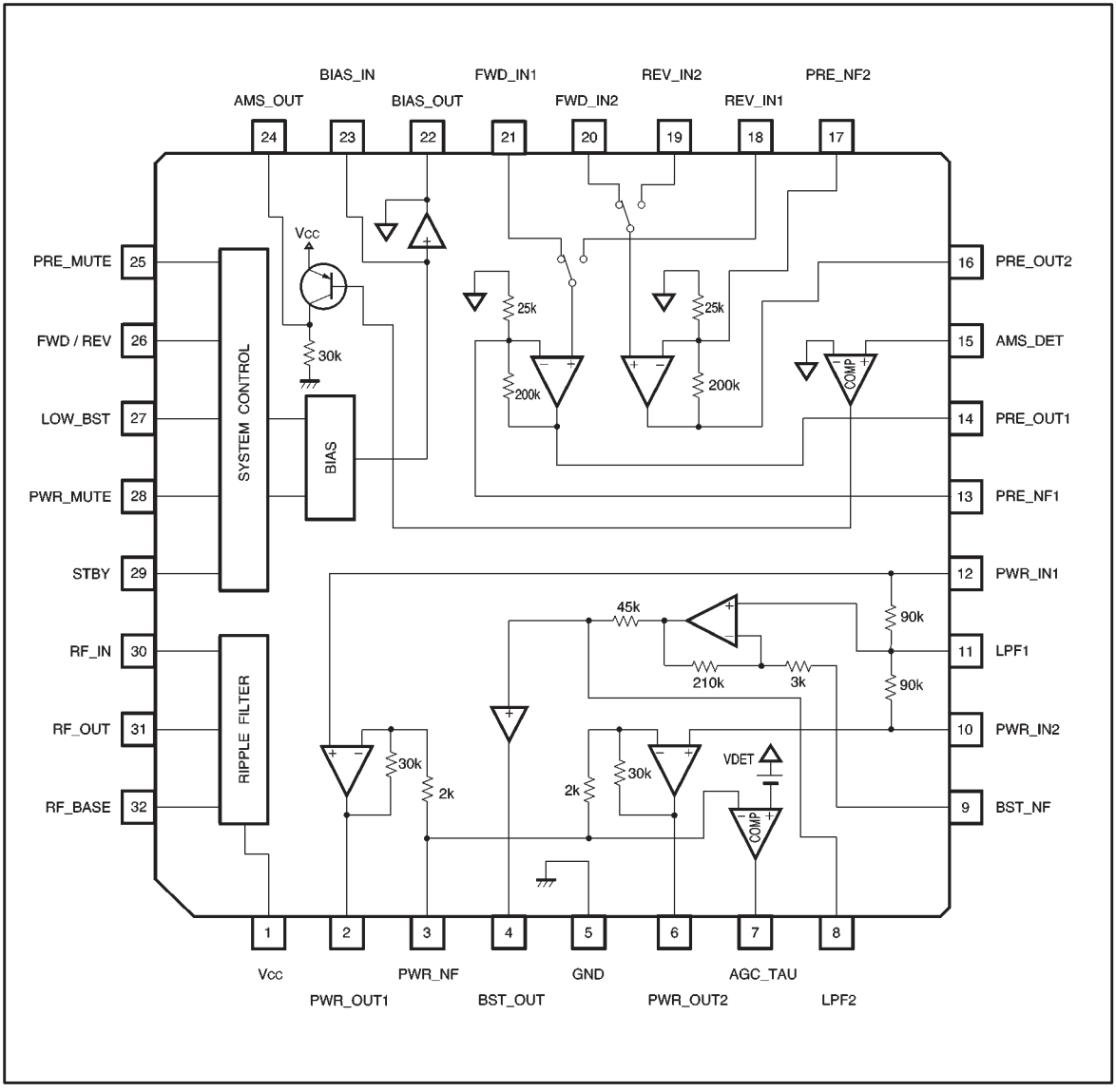
*1 Reduced by 4.0mW for each increase in Ta of 1℃ over 25℃.

●Recommended operating conditions (Ta = 25°C)

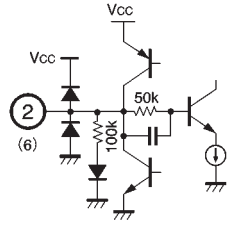
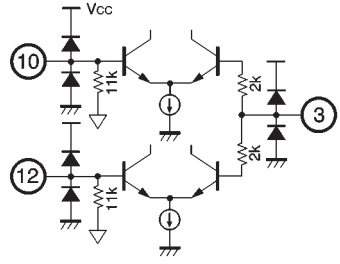
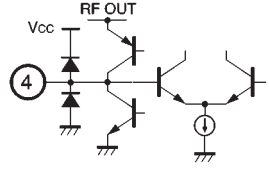
Parameter	Symbol	Limits	Unit
Power supply voltage	V_{CC}	0.95 (0.98) ～2.2*	V

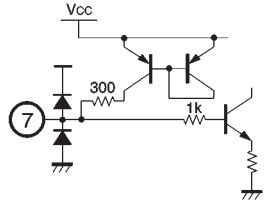
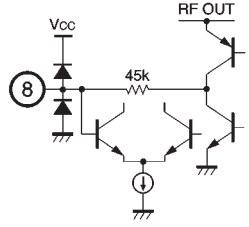
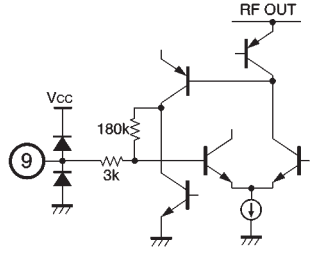
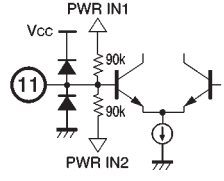
* The range V_{CC}=0.95V to 0.98V is the operating range for which oscillation will not occur. The ripple rejection for the ripple filter is stipulated for V_{CC} =1.1V.

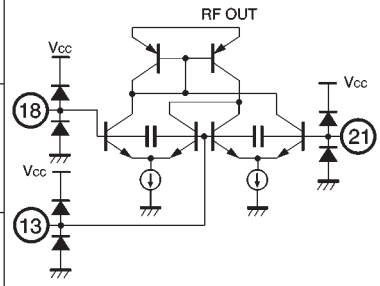
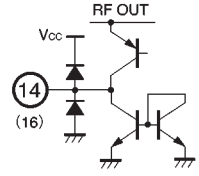
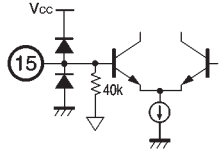
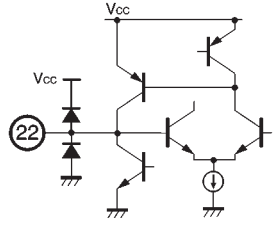
●Block diagram

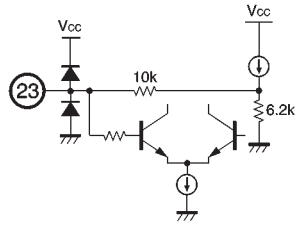
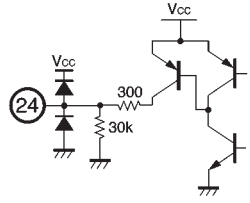
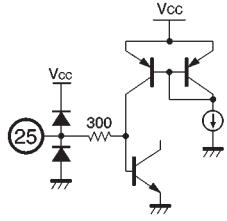
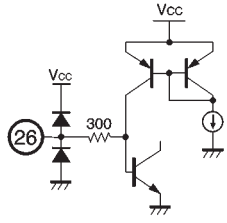


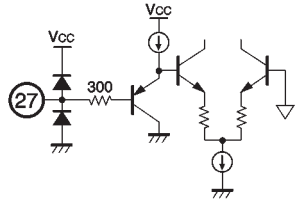
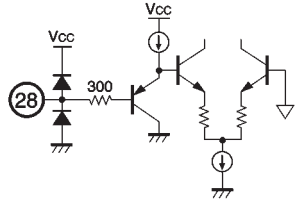
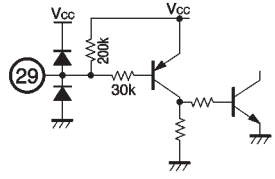
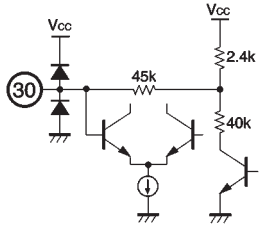
●Pin descriptions

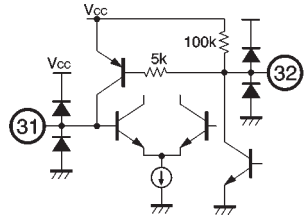
Pin No.	Pin name	I / O	Pin voltage	Internal equivalent circuit	Function
1	Vcc	I	1.2V	———	+B Power supply
2	PWR_OUT1	O	0.76V		Power amplifier output pin 1
6	PWR_OUT2	O	0.76V		Power amplifier output pin 2
3	PWR_NF	I	0.76V		Power amplifier NF
10	PWR_IN2	I	0.76V		Power amplifier input pin 2
12	PWR_IN1	I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

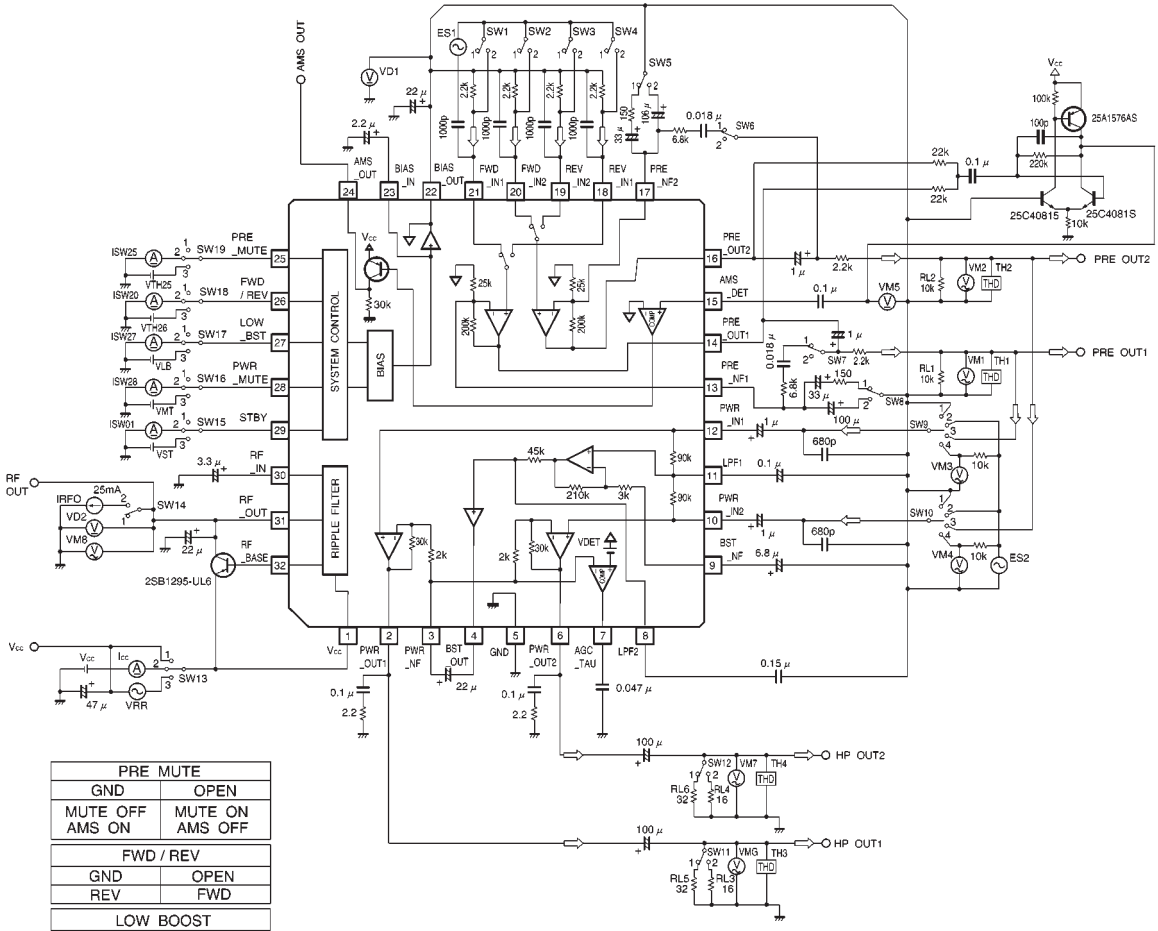
●Electrical characteristics (unless otherwise noted, Ta = 25°C, V_{CC} = 1.2V, f= 1kHz, R_L = 10kΩ (pre-amplifier), RL = 32Ω (power amplifier), L.BOOST OFF, 0dBm = 0.775Vrms)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Coniditions
〈Pre+power amplifier〉						
Voltage gain	GVTTL	54	57	60	dB	V_O=−20dBm
Circuit current 1	I_{CC1}	—	2.6	4.2	mA	V_{IN}=0, Rg=2.2kΩ
Circuit current 2	I_{CC2}	—	2.6	4.1	mA	L.BOOST ON, V_{IN}=0, Rg=2.2kΩ
Circuit current 3	I_{CC3}	—	6.8	10.3	mA	P_{OUT}=0.5mW×2ch, Rg=32Ω
Circuit current 4	I_{CC4}	—	5	20	μA	STBY OFF
〈Pre-amplifier〉						
Open-circuit voltage gain	G_{VO}	61	73	—	dB	V_O=−20dBm
Closed-circuit voltage gain	G_{VC}	33.5	35	36.5	dB	V_O=−20dBm
Maximum output voltage	V_{OM}	120	210	—	mV	THD=1%, DIN AUDIO
Total harmonic distortion	THD	—	0.2	0.6	%	V_O=−20dBm, G_{VC}=35dB (NAB), DIN AUDIO
Input conversion noise voltage	V_{NIN}	—	1.5	3	μV	Rg=2.2kΩ, G_{VC}=35dB (NAB), DIN AUDIO
Channel separation	CS	37	46	—	dB	Single-channel input, Rg=2.2kΩ V_O=−20dBm
FWD / REV REV crosstalk	CT_{F-R}	51	59	—	dB	Single-channel input, Rg=2.2kΩ V_O=−20dBm
Ripple rejection	RR	43	53	—	dB	Rg=2.2kΩ, V_{RR}=−30dBm, f_{RR}=100Hz I_{RFO}=25mA, BPF : 100Hz 1/4 OCT
Mute output voltage	V_{MUTE}	—	−110	−90	dBm	V_{IN}=−40dBm, PRE MUTE ON
〈Bass+power amplifier〉						
Voltage gain 1	Gv1	21.5	23.5	25.5	dB	V_O=−20dBm
Voltage gain 2	Gv2	21.7	23.7	25.7	dB	L.BOOST ON, V_O=−20dBm
Voltage gain 3	Gv3	31	35	39	dB	L.BOOST ON, f=100Hz, V_O=−20dBm
Rated output power	P_{OUT}	5	9	—	mW	THD=10%, DIN AUDIO, R_L=16Ω
Total harmonic distortion	THD	—	0.35	1.3	%	P_{OUT}=1mW, DIN AUDIO
Channel separation 1	CS1	33	40	—	dB	Single-channel input, Rg=0 V_O=−20dBm
Channel separation 2	CS2	35	45	—	dB	Single-channel input, L.BOOST ON, Rg=0, V_O=−20dBm
Output noise voltage 1	V_{NO1}	—	24	40	μV	Rg=0
Output noise voltage 2	V_{NO2}	—	48	80	μV	L.BOOST ON, Rg=0
Ripple rejection 1	RR1	64	74	—	dB	Rg=0, V_{RR}=−30dBm, f_{RR}=100Hz I_{RFO}=25mA, BPF : 100Hz 1/4 OCT
Ripple rejection 2	RR2	42	51	—	dB	L.BOOST ON Rg=0, V_{RR}=−30dBm, f_{RR}=100Hz I_{RFO}=25mA, BPF : 100Hz 1/4 OCT
Input resistance	R_{IN}	7.5	10	13	kΩ	—
Channel balance	CB	−1.5	0	1.5	dB	V_O=−20dBm
Mute output voltage	V_{MUTE}	—	−110	−90	dBm	V_{IN}=−30dBm
AGC level	V_{AGC}	−14.1	−12.5	−10.9	dBm	V_{IN}=43dBm, f=100Hz, R_L=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_{CC}=1.1V, V_{RR}=−30dBm, f_{RR}=100Hz I_{RFO}=25mA, BPF : 100Hz 1/4 OCT
DC output voltage	V_{RF}	0.89	0.94	—	V	V_{CC}=1.0V, I_{RFO}=25mA
〈Bias block〉						
DC output voltage	V_{BIAS}	0.68	0.76	0.83	V	V_{CC}=1.0V
〈AMS block〉						
Song detect level 1	VBS	−23.6	−22	−20.4	dBV	POWER MUTE ON When V_{24PIN}=0.6V_{P-O}
Song detect level 2	VMS	−39.6	−38	−36.4	dBV	POWER MUTE OFF When V_{24PIN}=0.6V_{P-O}
〈AMS-Ta characteristics〉						
Ambient temperature	Ta	−10	+25	+50	℃	—
Song detect level 3	ΔVBS	−1.1	0	+0.6	dB	POWER MUTE ON When V_{24PIN}=0.6V_{P-O}
Song detect level 4	ΔV_{MS}	−1.1	0	+0.6	dB	POWER MUTE OFF When V_{24PIN}=0.6V_{P-O}
〈Control block〉						
Standby on voltage	V_{STON}	—	—	0.4	V	"L" : POWER ON
Standby off voltage	V_{STOFF}	0.9	—	—	V	"H" / OPEN : POWER OFF
Standby pin current	I_{STBY}	—	23	45	μA	V_{29PIN}=0V
Power mute on threshold	V_{MTON}	—	—	0.05	V	"L" : POWER MUTE ON
Power mute off threshold	V_{MTOFF}	0.3	—	—	V	"H" / OPEN : POWER MUTE OFF
Power mute pin current	I_{SW28}	—	0.3	0.9	μA	V_{28PIN}=0.1V
FWD/REV low threshold	V_{TH26}	—	—	0.4	V	"L" : REV
FWD/REV pin current	I_{SW26}	—	3	6	μA	V_{26PIN}=0.2V
Low boost off threshold	V_{LBOFF}	—	—	0.1	V	"L" : L.BOOST OFF
Low boost on threshold	V_{LBON}	0.4	—	—	V	"H" / OPEN : L.BOOST ON
Low boost pin current	I_{SW27}	—	0.3	0.9	μA	V_{27PIN}=0.1V
Pre-mute low threshold	V_{TH25}	—	—	0.4	V	"L" : PRE MUTE OFF
Pre-mute pin current	I_{SW25}	—	3	6	μA	V_{25PIN}=0.2V

◎Not designed for radiation resistance.

●Measurement circuit



PRE MUTE	
GND	OPEN
MUTE OFF AMS ON	MUTE ON AMS OFF

FWD / REV	
GND	OPEN
REV	FWD

LOW BOOST	
GND	OPEN
OFF	ON

PWR MUTE	
GND	OPEN
MUTE ON AMS BS	MUTE OFF RMS MS

STBY	
GND	OPEN
POWER ON	POWER OFF

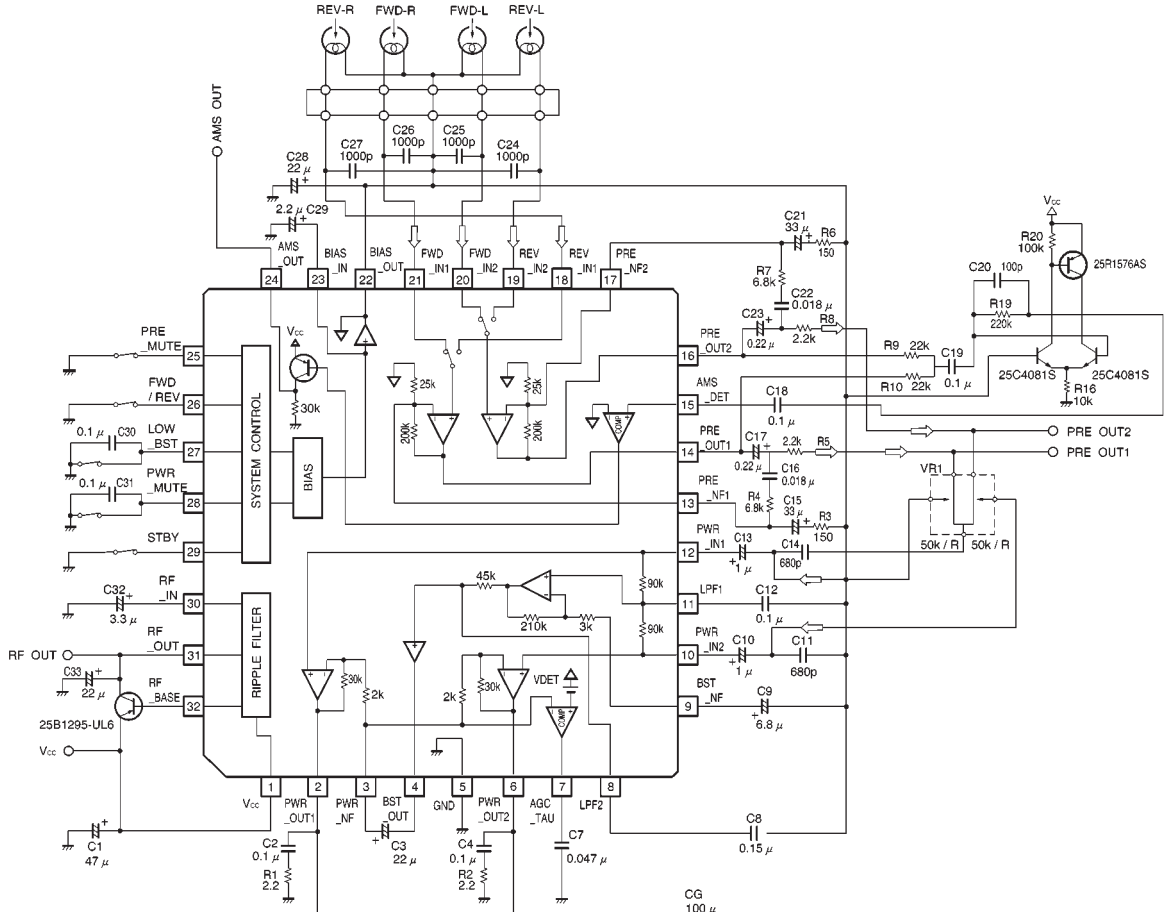
Fig.1

●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	GVTTL	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_{CC1}	1	1	1	1	↓	↓	↓	↓	1	1	↓	↓	2	↓	↓	↓	↓	2	↓
Circuit current 2	I_{CC2}	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	1	↓	↓
Circuit current 3	I_{CC3}	2 / 1	2 / 1	1 / 2	1 / 2	↓	↓	↓	↓	3	3	↓	↓	↓	↓	↓	↓	2	1 / 2	↓
Circuit current 4	I_{CC4}	1	1	1	1	↓	↓	↓	↓	1	1	↓	↓	↓	↓	1	↓	↓	2	↓
〈Pre+amplifier〉																				
Open-circuit voltage gain	G_{VO}	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_{VC}	↓	↓	↓	↓	1	1	1	1	↓	↓	↓	↓	↓	↓	↓	↓	1	↓	↓
Maximum output voltage	V_{OM}	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
Total harmonic distortion	THD	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
Input conversion noise voltage	V_{NIN}	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_{F-R}	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_{MUTE}	2 / 1	2 / 1	1 / 2	1 / 2	↓	↓	↓	↓	↓	↓	↓	↓	1	1	↓	↓	↓	↓	1
〈Bass+power amplifier〉																				
Voltage gain 1	G_{V1}	1	1	1	1	1	1	1	1	2	2	1	1	1	1	2	1	2	2	2
Voltage gain 2	G_{V2}	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	1	↓	↓
Voltage gain 3	G_{V3}	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓
Rated output power	P_{OUT}	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	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_{NO1}	↓	↓	↓	↓	↓	↓	↓	↓	1	1	↓	↓	↓	↓	↓	↓	2	↓	↓
Output noise voltage 2	V_{NO2}	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	1	↓	↓
Ripple rejection 1	RR1	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	3	2	↓	↓	2	↓	↓
Ripple rejection 2	RR2	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	1	↓	↓
Input resistance	R_{IN}	↓	↓	↓	↓	↓	↓	↓	↓	4	4	↓	↓	↓	↓	↓	↓	2	↓	↓
Channel balance	CB	↓	↓	↓	↓	↓	↓	↓	↓	2	2	↓	↓	↓	↓	↓	↓	↓	↓	↓
Mute output voltage	V_{MUTE}	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	2	↓	↓	↓
AGC level	V_{AGC}	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	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_{RF}	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	1	1	↓	↓	↓	↓	↓
〈Bias block〉																				
DC output voltage	V_{BIAS}	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_{BS}	2	2	1	1	1	1	1	1	1	1	1	1	1	1	2	2	2	2	2
Song detect level 2	V_{MS}	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓

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_{ST}	1	1	1	1	1	1	1	1	1	1	1	1	1	2	3	1	2	2	2
Standby pin current	I_{STBY}	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	1	2	↓	↓	↓	↓
Power mute on/off threshold	V_{MT}	↓	↓	↓	↓	↓	↓	↓	↓	2	2	↓	↓	↓	↓	↓	3	↓	↓	↓
Power mute pin current	I_{SW28}	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	2	↓	↓	↓
FWD/REV low threshold	V_{TM26}	2 / 1	2 / 1	1 / 2	1 / 2	↓	↓	↓	↓	1	1	↓	↓	↓	↓	↓	1	↓	3	↓
FWD/REV pin current	I_{SW26}	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	2	↓
Low boost on/off threshold	V_{LB}	1	1	1	1	↓	↓	↓	↓	2	2	↓	↓	↓	↓	↓	↓	3	↓	↓
Low boost pin current	I_{SW27}	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	2	↓	↓
Pre-mute low threshold	V_{TH25}	2 / 1	2 / 1	1 / 2	1 / 2	↓	↓	↓	↓	1	1	↓	↓	↓	↓	↓	↓	↓	1 / 2	3
Pre-mute pin current	I_{SW25}	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	↓	2

●Application example



PRE MUTE	
GND	OPEN
MUTE OFF AMS ON	MUTE ON AMS OFF

FWD / REV	
GND	OPEN
REV	FWD

LOW BOOST	
GND	OPEN
OFF	ON

PWA MUTE	
GND	OPEN
MUTE ON RMS BS	MUTE OFF RMS MS

STBY	
GND	OPEN
POWER ON	POWER OFF

Fig.2

●Electrical characteristics curves

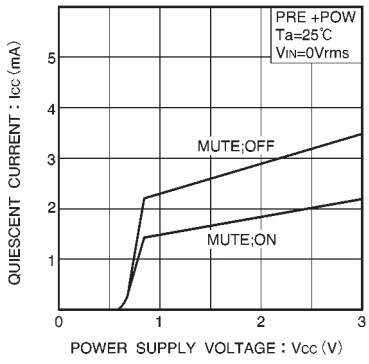


Fig.3 Quiescent current vs. power supply voltage

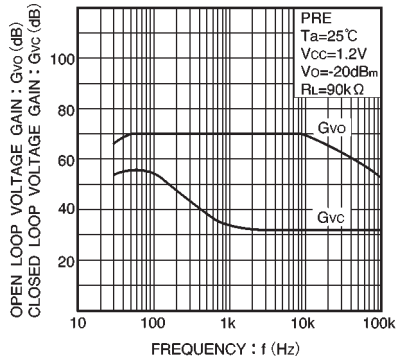


Fig.4 Voltage gain vs. frequency

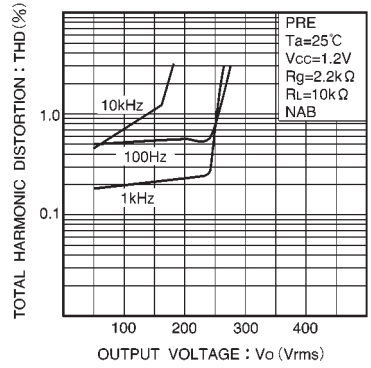


Fig.5 Total harmonic distortion vs. output voltage

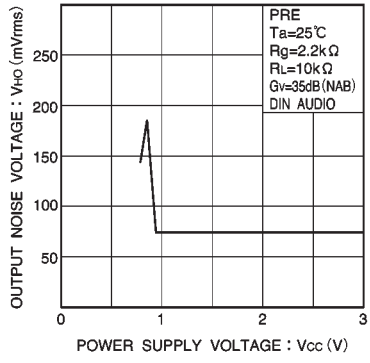


Fig.6 Output noise voltage gain vs. power supply voltage

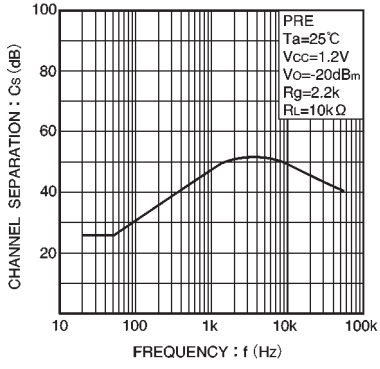


Fig.7 Channel separation vs. frequency

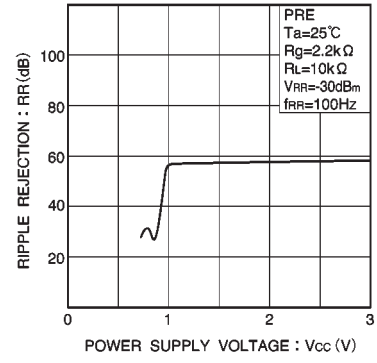


Fig.8 Ripple rejection vs. power supply voltage

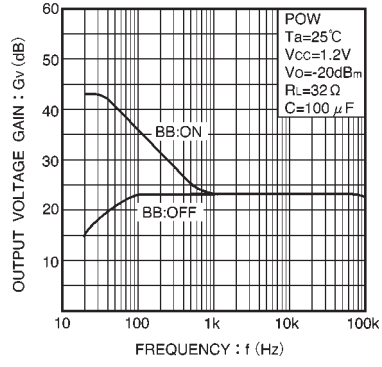


Fig.9 Voltage gain vs. frequency

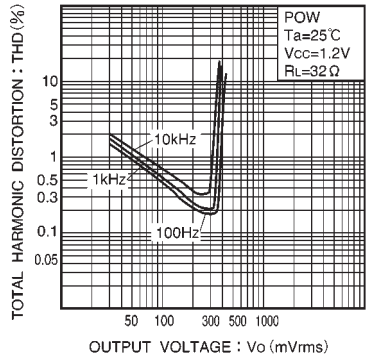


Fig.10 Total harmonic distortion vs. output voltage

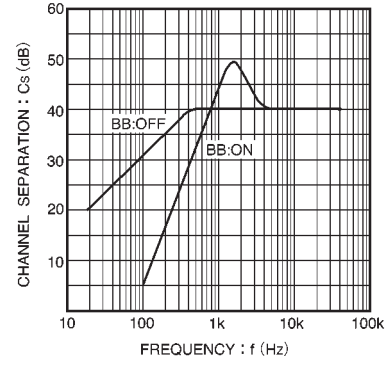


Fig.11 Channel separation vs. frequency

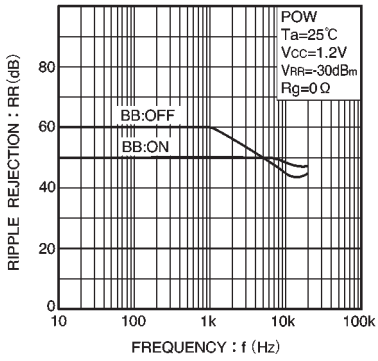


Fig.12 Ripple rejection vs. frequency

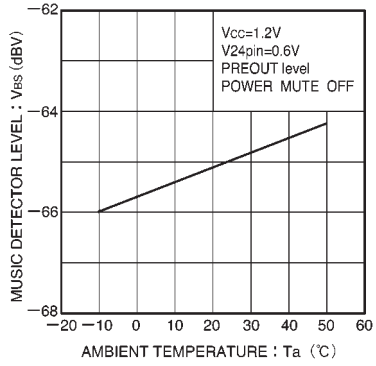


Fig.13 Song detect 3 vs. temperature

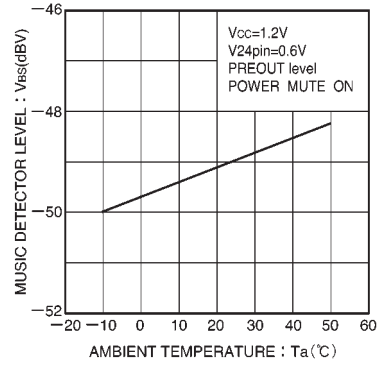


Fig.14 Song detect level vs. temperature

●External dimensions (Unit:s mm)