

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 ^{*1}	mW
Operating temperature	T_{opr}	-10~+60	°C
Storage temperature	T_{stg}	-55~+125	°C

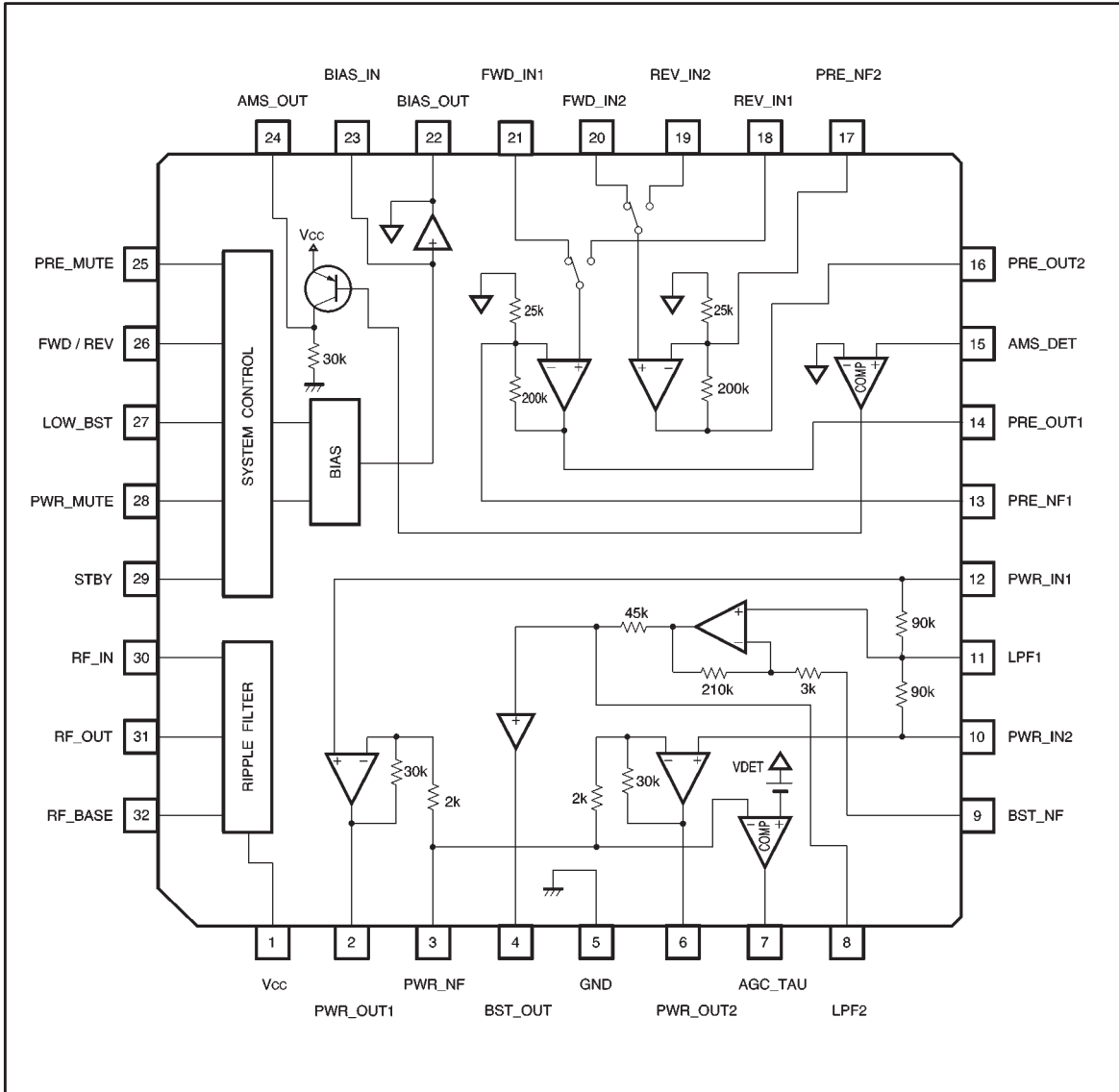
*1 Reduced by 4.0mW for each increase in T_a of 1°C over 25°C.

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

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

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

● Block diagram



● Pin descriptions

Pin No.	Pin name	I / O	Pin voltage	Internal equivalent circuit	Function
1	V _{CC}	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 Power amplifier input pin 2 Power amplifier input pin 1
10	PWR_IN2	I	0.76V		
12	PWR_IN1	I	0.76V		
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

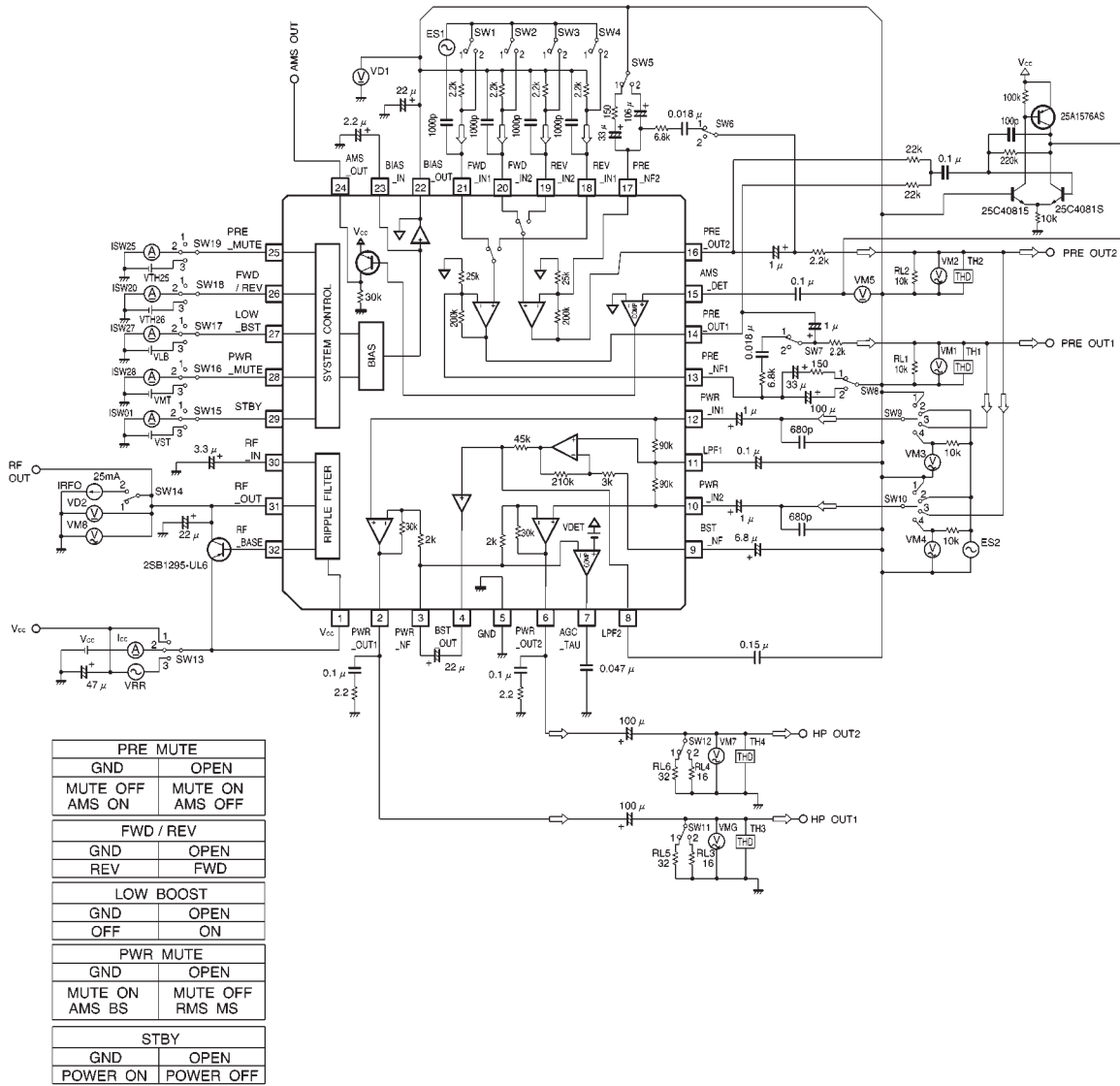
- Electrical characteristics (unless otherwise noted, $T_a = 25^\circ\text{C}$, $V_{CC} = 1.2\text{V}$, $f = 1\text{kHz}$, $R_L = 10\text{k}\Omega$ (pre-amplifier), $R_L = 32\Omega$ (power amplifier), L.BOOST OFF, $0\text{dBm} = 0.775\text{Vrms}$)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
〈Pre+power amplifier〉						
Voltage gain	GV _{TTL}	54	57	60	dB	$V_o = -20\text{dBm}$
Circuit current 1	I _{CC1}	—	2.6	4.2	mA	$V_{IN} = 0$, $R_g = 2.2\text{k}\Omega$
Circuit current 2	I _{CC2}	—	2.6	4.1	mA	L.BOOST ON, $V_{IN} = 0$, $R_g = 2.2\text{k}\Omega$
Circuit current 3	I _{CC3}	—	6.8	10.3	mA	$P_{OUT} = 0.5\text{mW} \times 2\text{ch}$, $R_g = 32\Omega$
Circuit current 4	I _{CC4}	—	5	20	μA	STBY OFF
〈Pre-amplifier〉						
Open-circuit voltage gain	G _{VO}	61	73	—	dB	$V_o = -20\text{dBm}$
Closed-circuit voltage gain	G _{VC}	33.5	35	36.5	dB	$V_o = -20\text{dBm}$
Maximum output voltage	V _{OM}	120	210	—	mV	THD=1%, DIN AUDIO
Total harmonic distortion	THD	—	0.2	0.6	%	$V_o = -20\text{dBm}$, $G_{VC} = 35\text{dB}$ (NAB), DIN AUDIO
Input conversion noise voltage	V _{NIN}	—	1.5	3	μV	$R_g = 2.2\text{k}\Omega$, $G_{VC} = 35\text{dB}$ (NAB), DIN AUDIO
Channel separation	CS	37	46	—	dB	Single-channel input, $R_g = 2.2\text{k}\Omega$ $V_o = -20\text{dBm}$
FWD / REV REV crosstalk	CT _{F-R}	51	59	—	dB	Single-channel input, $R_g = 2.2\text{k}\Omega$ $V_o = -20\text{dBm}$
Ripple rejection	RR	43	53	—	dB	$R_g = 2.2\text{k}\Omega$, $V_{RR} = -30\text{dBm}$, $f_{RR} = 100\text{Hz}$ $I_{RFO} = 25\text{mA}$, BPF : 100Hz 1/4 OCT
Mute output voltage	V _{MUTE}	—	-110	-90	dBm	$V_{IN} = -40\text{dBm}$, PRE MUTE ON
〈Bass+power amplifier〉						
Voltage gain 1	G _{V1}	21.5	23.5	25.5	dB	$V_o = -20\text{dBm}$
Voltage gain 2	G _{V2}	21.7	23.7	25.7	dB	L.BOOST ON, $V_o = -20\text{dBm}$
Voltage gain 3	G _{V3}	31	35	39	dB	L.BOOST ON, $f = 100\text{Hz}$, $V_o = -20\text{dBm}$
Rated output power	P _{OUT}	5	9	—	mW	THD=10%, DIN AUDIO, $R_L = 16\Omega$
Total harmonic distortion	THD	—	0.35	1.3	%	$P_{OUT} = 1\text{mW}$, DIN AUDIO
Channel separation 1	CS1	33	40	—	dB	Single-channel input, $R_g = 0$ $V_o = -20\text{dBm}$
Channel separation 2	CS2	35	45	—	dB	Single-channel input, L.BOOST ON, $R_g = 0$, $V_o = -20\text{dBm}$
Output noise voltage 1	V _{NO1}	—	24	40	μV	$R_g = 0$
Output noise voltage 2	V _{NO2}	—	48	80	μV	L.BOOST ON, $R_g = 0$
Ripple rejection 1	RR1	64	74	—	dB	$R_g = 0$, $V_{RR} = -30\text{dBm}$, $f_{RR} = 100\text{Hz}$ $I_{RFO} = 25\text{mA}$, BPF : 100Hz 1/4 OCT
Ripple rejection 2	RR2	42	51	—	dB	L.BOOST ON $R_g = 0$, $V_{RR} = -30\text{dBm}$, $f_{RR} = 100\text{Hz}$ $I_{RFO} = 25\text{mA}$, BPF : 100Hz 1/4 OCT
Input resistance	R _{IN}	7.5	10	13	k Ω	—
Channel balance	CB	-1.5	0	1.5	dB	$V_o = -20\text{dBm}$
Mute output voltage	V _{MUTE}	—	-110	-90	dBm	$V_{IN} = -30\text{dBm}$
AGC level	V _{AGC}	-14.1	-12.5	-10.9	dBm	$V_{IN} = 43\text{dBm}$, $f = 100\text{Hz}$, $R_L = 16\Omega$ AGC level measured at the end of the 16 Ω 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	T_a	-10	+25	+50	°C	—
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	ΔVMS	-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	MUTE ON
AMS ON	AMS OFF
FWD / REV	
GND	OPEN
REV	FWD
LOW BOOST	
GND	OPEN
OFF	ON
PWR MUTE	
GND	OPEN
MUTE ON	MUTE OFF
AMS BS	RMS MS
STBY	
GND	OPEN
POWER ON	POWER OFF

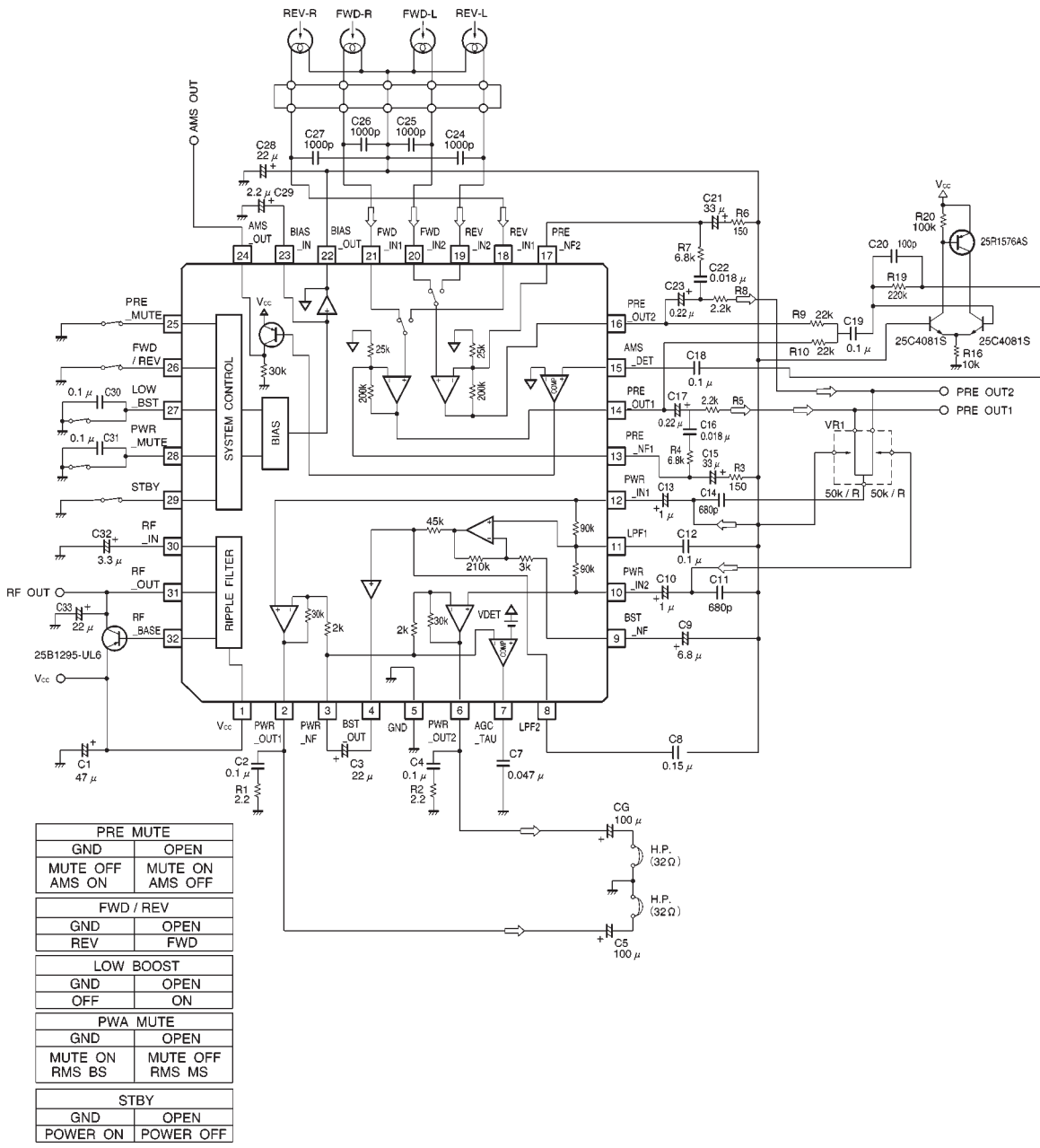
Fig.1

● 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	GV _{TTL}	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	MUTE ON
AMS ON	AMS OFF
FWD / REV	
GND	OPEN
REV	FWD
LOW BOOST	
GND	OPEN
OFF	ON
PWA MUTE	
GND	OPEN
MUTE ON	MUTE OFF
RMS BS	RMS MS
STBY	
GND	OPEN
POWER ON	POWER OFF

Fig.2

● Electrical characteristics curves

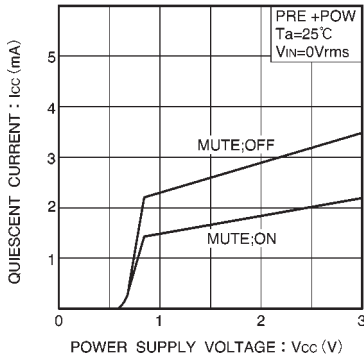


Fig.3 Quiescent current vs. power supply voltage

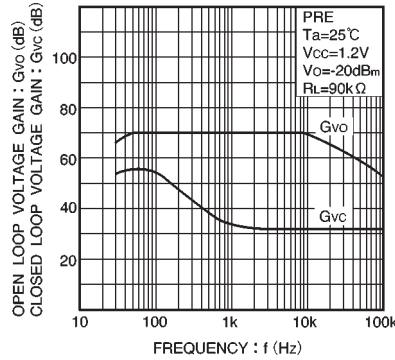


Fig.4 Voltage gain vs. frequency

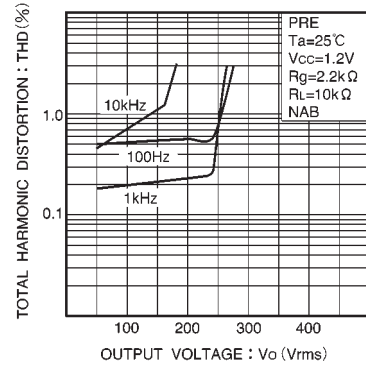


Fig.5 Total harmonic distortion vs. output voltage

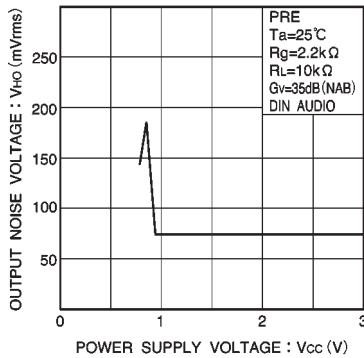


Fig.6 Output noise voltage gain vs. power supply voltage

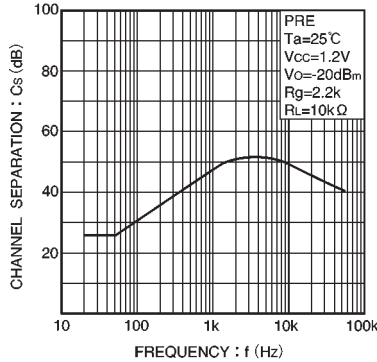


Fig.7 Channel separation vs. frequency

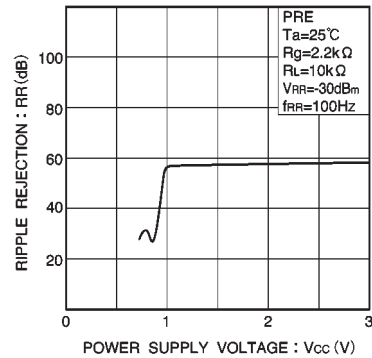


Fig.8 Ripple rejection vs. power supply voltage

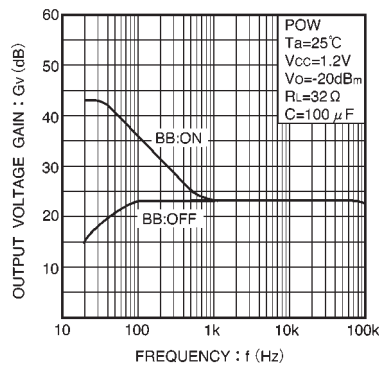


Fig.9 Voltage gain vs. frequency

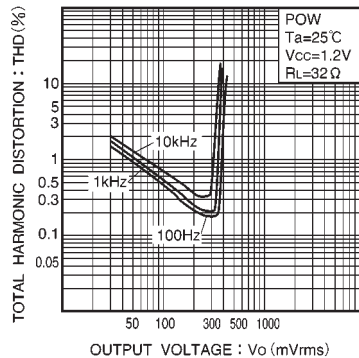


Fig.10 Total harmonic distortion vs. output voltage

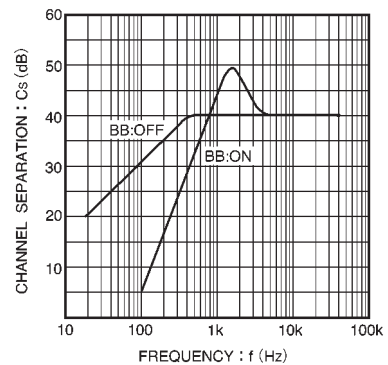


Fig.11 Channel separation vs. frequency

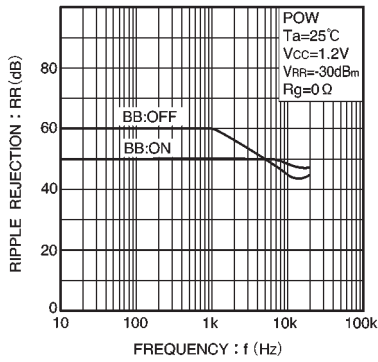


Fig.12 Ripple rejection vs. frequency

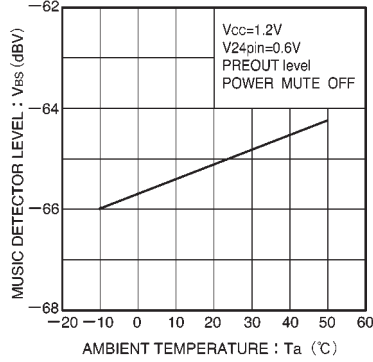


Fig.13 Song detect 3 vs. temperature

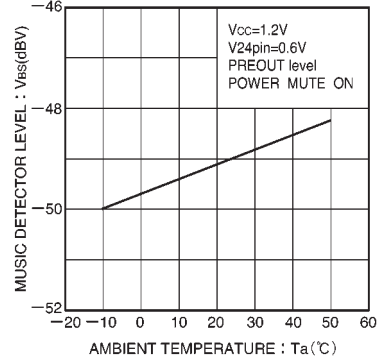


Fig.14 Song detect level vs. temperature

● External dimensions (Unit:s mm)

