Pre-power amplifier for headphone stereos

BA3612AKV

The BA3612AKV is configured of a pre-amplifier and a headphone amplifier, and contains internal AMS, B.B, AVLS, and BEEP amplifier functions. Also, this IC can be used in combination with the BA3641FV to enable configuration of recording and playback sets.

●Applications

Portable cassette players

●Features

1) Low current consumption.
2) Internal AMS function.
3) Internal B.B function.
4) Internal AVLS function.
5) Internal BEEP amplifier.
6) Supports Dolby-B.
7) Supports OCL output.

●Absolute maximum ratings (Ta = 25°C)

Parameter	Symbol	Limits	Unit
Power supply voltage	V_{DD}	5.0	V
Power dissipation	P_d	400*	mV
Operating temperature	Topr	−15～+60	℃
Storage temperature	Tstg	−55～+125	℃

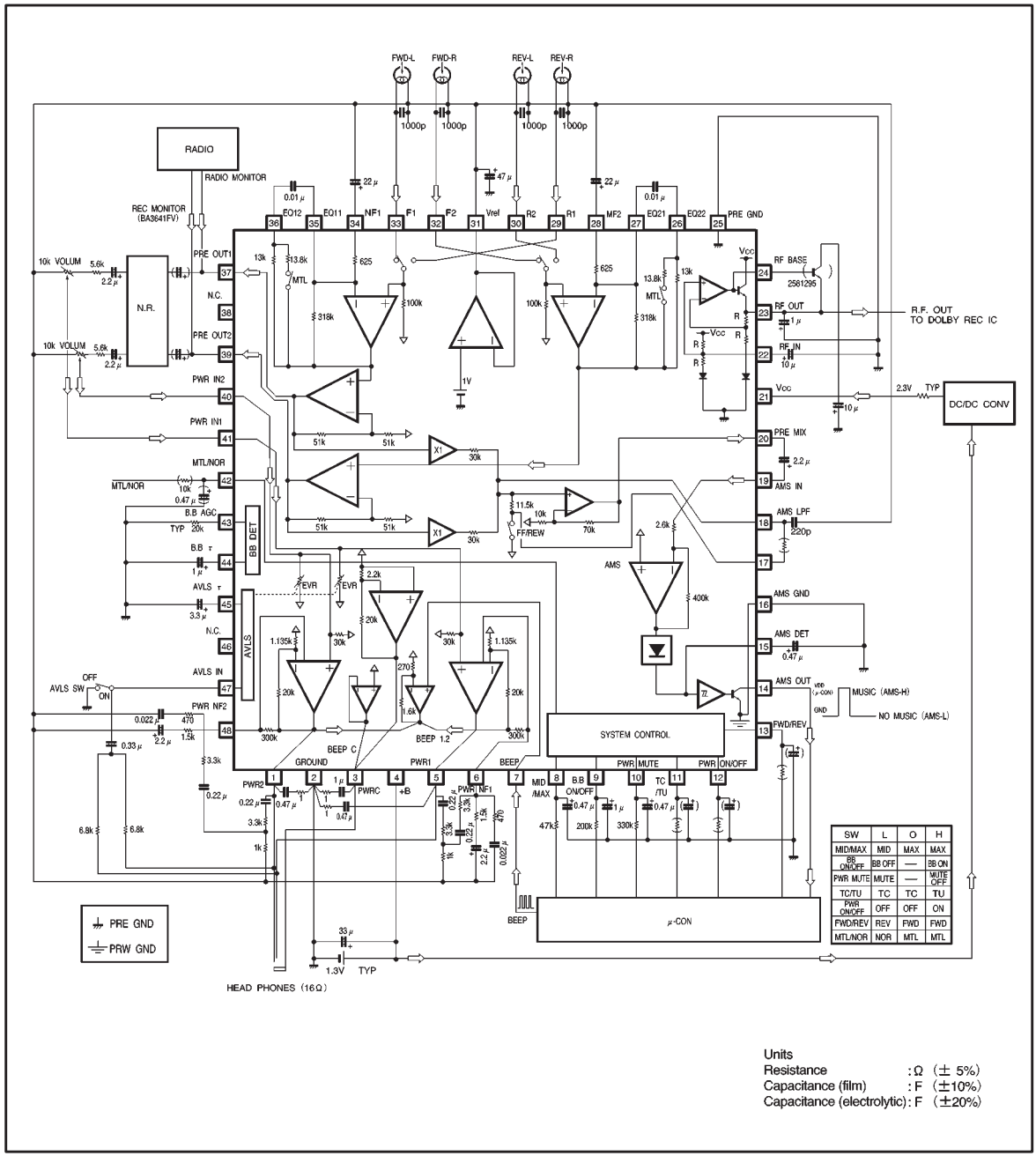
*Reduced by 4.0mW for each increase in Ta of 1℃ over 25℃.
when mounted on a 70mm × 70mm × 1.6mm glass epoxy board.

●Recommended operating conditions (Ta = 25°C)

Parameter	Symbol	Limits	Unit
Power supply voltage 1	+B	0.90～2.20	V
Power supply voltage 2	V_{CC}	1.70～4.40*	V

* In terms of basic operation, normally a high voltage of 0.4V higher than +B is applied for V_{CC}.
A relation of V_{CC}=+B × 2 is recommended.

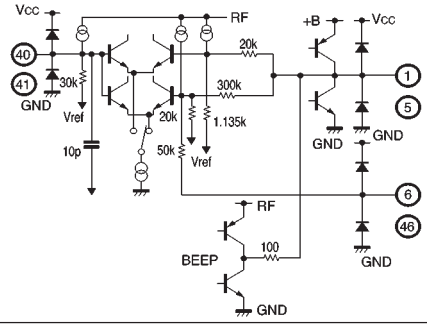
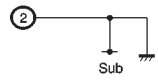
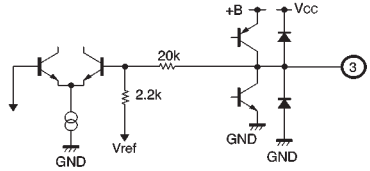
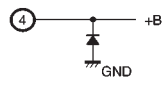
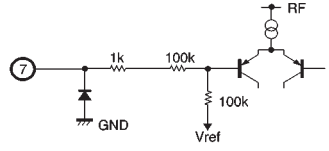
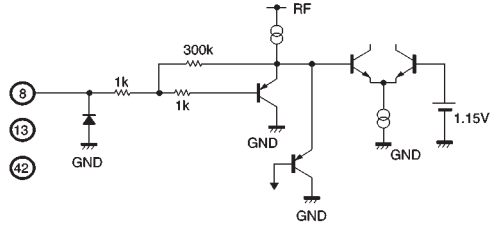
●Block diagram

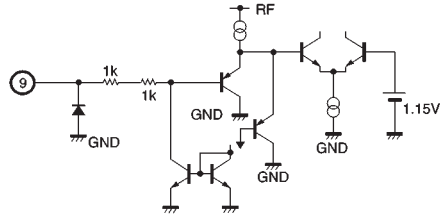
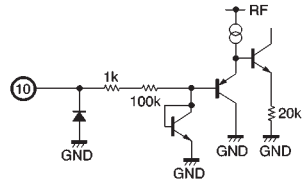
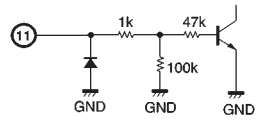
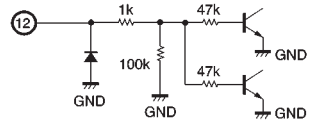
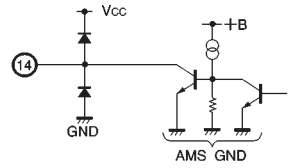
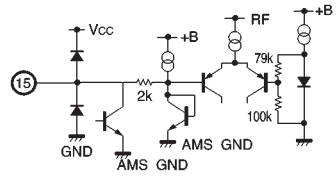
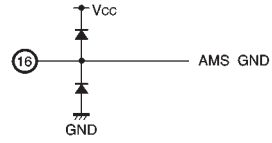


Units
Resistance : Ω (± 5%)
Capacitance (film) : F (±10%)
Capacitance (electrolytic) : F (±20%)

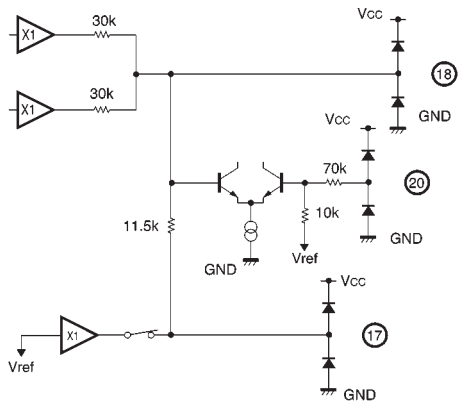
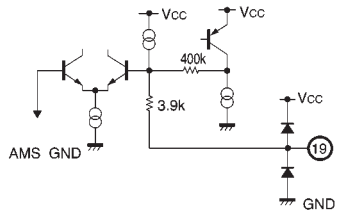
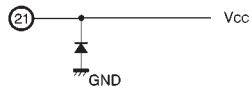
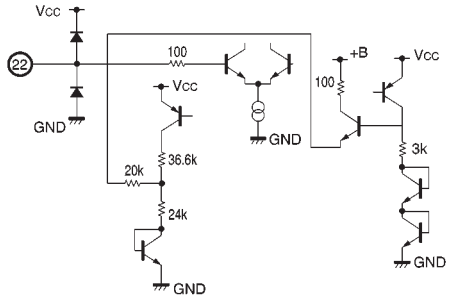
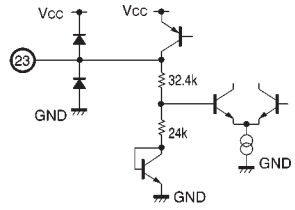
●Pin descriptions

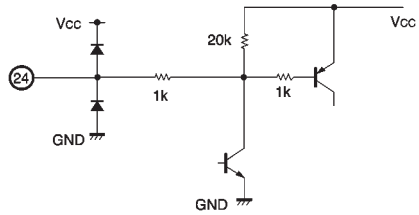
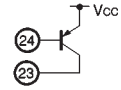
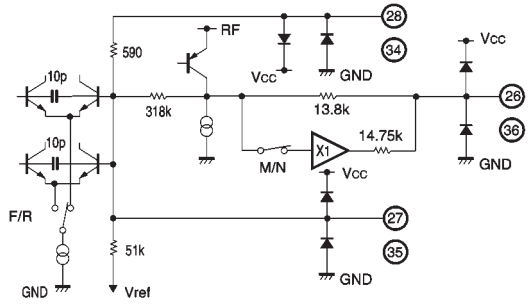
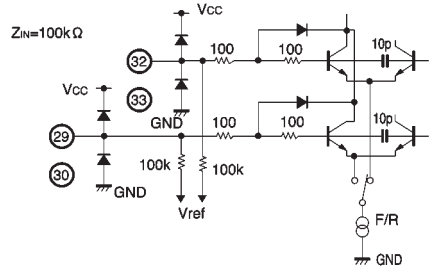
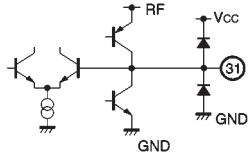
(The pin voltage of V_{CC} = 2.3V, +B = 1.3V is the standard value for the measurement circuit under quiescent conditions. Modes: PWR-ON, TC, FWD, NOR, Mute-OFF, B.B-OFF, AVLS-OFF)

Pin No	Pin name	DC voltage	Equivalent circuit	Function
1 5	PWR2 PWR1	0.6		Power amplifier output BEEP amplifier output Zo ≒ 1.2Ω (power amplifier)
8 48	PWR NF1 PWR NF2	1.0		NF pin when power amplifier is B.B
2	GROUND	0		PWR GND (Sub)
3	PWR C	0.6		Power amplifier output (Center amplifier) Zo ≒ 6.7Ω
4	+B	1.3		Positive power supply
7	BEEP	1.0		BEEP input Zin ≒ 200kΩ
8	B.B MID / MAX	– (OPEN) 0.65 (MAX) 0.2 (MID)		For bass boost MID / MAX switching
13	Forward Reverse	– (OPEN) 0.65 (FWD)		Pre-amplifier forward/reverse input switching
42	Metal / Normal	– (OPEN) 0.2 (NOR)		Pre-amplifier equalizer switching between Metal (70 μs) and Normal (120 μs)

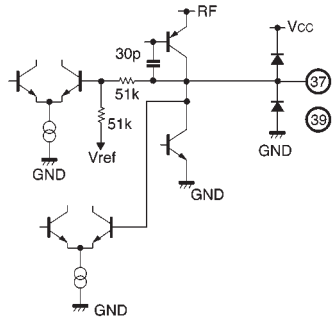
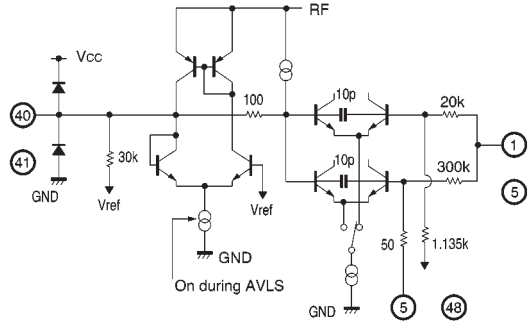
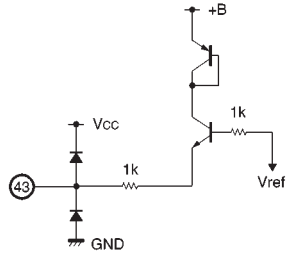
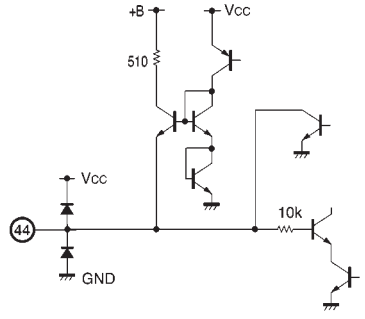
Pin No.	Pin name	DC voltage	Equivalent circuit	Function
9	B.B ON / OFF	— (OPEN) 0.3 (B.B-OFF)		Bass boost/normal switching
10	MUTE	— (OPEN) 0.65 (MUTE-OFF)		Mute ON/OFF switching Zin=100kΩ
11	TC / TU	0 (OPEN) 0.4 (TC)		Switching between TC (tape playback) and TU (radio monitor) Zin≒100kΩ
12	ST-BY (PWR ON / OFF)	0 (OPEN) 0.77 (PWR-ON)		IC power supply ON/OFF Zin≒100kΩ
14	AMSOUT	— (when curve exists) 0 (when no curve exists)		Mute detector output Non-mute: High Mute : Low
15	AMS DET	0 (when curve exists) 0.65 (when no curve exists)		Mute detector comparator output smoothing pin
16	AMS GND	0 *		Dedicated mute detector block GND

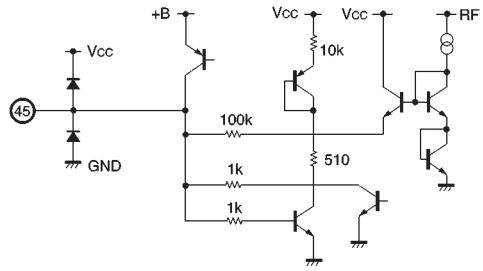
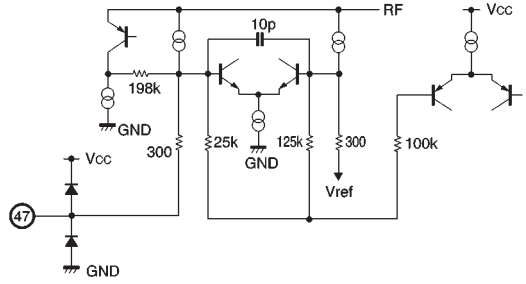
*When GND is connected outside IC

Pin No.	Pin name	DC voltage	Equivalent circuit	Function
17	AMS LVL	1.0		Threshold value adjustment pin for mute detector high-speed mode
18	AMS LPF	1.0		Filter configuration pin to prevent malfunction from mute detector noise Zin ≒ 1.5kΩ (for playback) Zin ≒ 7kΩ (for fast for ward / rewind)
20	PRE MIX	1.0		Output pin which amplifies PRE OUT MIX output to 18 dB
19	AMS IN	1.0		Phase detection amplifier input for mute detector block
21	Vcc	2.3		Positive power supply (booster voltage)
22	RF IN	1.2		Ripple filter amplifier input Zin≒44kΩ
23	RF OUT	2.0		Ripple filter amplifier output Zin≒56.4kΩ

Pin No.	Pin name	DC voltage	Equivalent circuit	Function
24	RF Base	1.3		For connection of external transistor for ripple filter amplifier. 2SB1295 or equivalent is recommended as external transistor. See diagram below for connection. 
25	Pre GND	0*		Low-current GND in IC
26 36	EQ22 EQ12	1.0 1.0		Pre-amplifier equalizer Connect capacitors between pins 26 and 27 and between pins 35 and 36.
27 35	EQ21 EQ11	1.0 1.0		Pre-amplifier equalizer
28 34	NF2 NF1	1.0 1.0		Pre-amplifier NF
29	R1	1.0		Pre-amplifier reverse-1 channel input
30	R2	1.0		Pre-amplifier reverse-2 channel input
32	F2	1.0		Pre-amplifier forward-2 channel input
33	F1	1.0		Pre-amplifier forward-1 channel input
31	Vref	1.0		Vref amplifier output Zo≒10Ω

*When GND is connected outside IC

Pin No.	Pin name	DC voltage	Equivalent circuit	Function
37 39	Pre OUT1 Pre OUT2	1.0 1.0		Pre-amplifier output Zo≒ 130Ω (for TC) Zo=100kΩ (for TU)
40 41	PWR IN2 PWR IN1	1.0 1.0		Power amplifier input Zin=30kΩ
43	B.B AGC	—		Controls AGC level during bass boost
44	B.B τ	0		AGC phase detection output smoothing pin during bass boost

Pin No.	Pin name	DC voltage	Equivalent circuit	Function
45	AVLS τ	0		Detector output smoothing pin during AVLS
47	AVLS IN	1.0		AVLS input AVLS ON / OFF switching

●Electrical characteristics

(unless otherwise noted, ＋B = 1.3V, V_{CC} = 2.3V, f = 1kHz, PreOutR_L = 5kΩ, PWROutR_L = 16Ω (OCL), Ta = 25°C, and measurement condition pertaining to ripple: V_{CC} and ＋B are common-mode input)

Parameter		Symbol	Min.	Typ.	Max.	Unit	Coniditions
〈Total〉							
Quiescent current		Icc1B	—	3.0	4.5	mA	Power On, PWR-Mute OFF, TC B.B-OFF, AVLS-OFF
		Icc1V	—	4.9	6.0		
		Icc2B	—	0.3	0.8	mA	Power On, PWR-Mute ON, TC B.B-OFF, AVLS-OFF
		Icc2V	—	4.1	5.5		
		Icc3B	—	3.0	4.5	mA	Power On, PWR-Mute OFF, Tuner B.B-OFF, AVLS-OFF
		Icc3V	—	4.2	5.5		
		Icc4B	—	0	5.0	μA	Power OFF, PWR-Mute OFF, TC B.B-OFF, AVLS-OFF
		Icc4V	—	0	5.0		
Current consumption at 0.5mW		Icc5B	—	14.0	15.5	mA	PWR input=−45.8dBV OCL, TC, B.B-OFF, AVLS-OFF
		Icc5V	—	4.9	6.0		
〈Pre block〉							
Closed-loop voltage gain		Gvc1	34.6	35.6	36.6	dB	V_O=−20.0dBv
Max. output voltage		Vom1	185	250	—	mV	＋B=0.9V, V_{CC}=1.7V, THD=1%
Total harmonic distortion		THD1	—	0.12	0.5	%	＋B=0.9V, V_{CC}=1.7V, Vo=−20.0dBv
Input reduced noise voltage		V_{NIN}	—	1.25	2.0	μVrms	Rg=1.0kΩ, DIN-AUDIO Converted using NAB 1kHz gain
Crosstalk between channels		CTc1	65	—	—	dB	D_O=−20.0dBv, Rg=1kΩ 1kHz BPF＋DIN-AUDIO
Crosstalk between F/R		CTfr	68	—	—	dB	
AMS threshold	Mute-OFF	amsP	−69.5	−67.0	−64.5	dBv	Cams=2.2μF, Rams=0Ω, TU-ON PRE OUT input value, V_{AMSOUT}>0.3V
	Mute-ON	amsF	−62.5	−60.0	−57.5		
Ripple leak (Pre＋R.F.)		RL1	—	—	−76	dBv	＋B=1.0V＋(−26dBv), f=130Hz Vcc=2.0V＋(−20dBv), f=130Hz Irf=−1.5mA 130Hz BPF＋DIN-AUDIO
Pre-muting attenuation		Mute1	75	—	—	dB	Vcc=1.7V, Rg=1kΩ, Vo=−20dBv 1kHz BPF＋DIN-AUDIO
Metal-f characteristic		ΔGvM	−5.44	−4.54	−3.64	dB	Deviation at 10kHz, Vo=−20dBv

◎Not designed for radiation resistance.

(unless otherwise noted, +B = 1.3V, V_{CC} = 2.3V, f = 1kHz, PreOutR_L = 5kΩ, PWROutR_L = 16Ω (OCL), Ta = 25°C, and measurement condition pertaining to ripple: V_{CC} and +B are common-mode input)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Coniditions
〈Power block〉						
Closed-loop voltage gain	$G_{VC}2$	22.5	24.0	25.5	dB	V_O=−20.0dBv
Interchannel balance	CB	−1.5	0.0	1.5		
Output power	P_O	6.5	10.0	—	mW	+B=1.5V, THD=10%, R_L=16Ω
Total harmonic distortion 1	THDp1	—	0.3	0.9	%	P_O=1mW, 400~30kHz BPF
Total harmonic distortion 2	THDp2	—	0.4	1.0	%	P_O=1mW, f=10kHz, 30kHz LPF
Output noise voltage	V_{NO}	—	19.0	32.0	μVrms	Rg=600Ω, DIN-AUDIO
Crosstalk	CT_C2	28.0	—	—	dB	Rg=3.3Ω, V_O=−40dBv 1kHz BPF+DIN-AUDIO
Ripple leak	RL2	—	−92.5	−87.0	dBv	+B=1.0V+(−26dBv), f=130Hz Vcc=2.0V+(−20dBv), f=130Hz Rg=600Ω, 130HzBPF, Irf=−1.5mA
Muting attenuation	Mute2	80	—	—	dB	f=1kHz, V_O=−20dBv B.B-MAX, 1kHz BPF+DIN-AUDIO
Input resistance	Z_{IN}	25	30	35	kΩ	—
DC offset voltage	ΔVo	−25	0.0	15	mV	A/B-Amp in relation to C-Amp
〈Ripple filter〉						
Ripple rejection	RR	26.0	—	—	dB	Vcc=2.0V+(−20dBv), f=130Hz 130Hz BPF+DIN-AUDIO, Irf=−1.5mA
DC output voltage	V_{rf}	1.42	1.50	—	V	Vcc=1.7V, Irf=0mA
〈Boost〉						
Boost ON / OFF voltage gain deviation	ΔB.B	−2.0	0.0	1.0	dB	f=1kHz, V_{IN}=−60dBv
Boost amount 1*	BG1	17.5	20.0	—	dB	f=50Hz, V_{IN}=−60dBv, B.B-MAX
Boost amount 2**	BG2	3.7	5.2	6.7	dB	f=10kHz, V_{IN}=−60dBv, B.B-MAX
Boost amount 3*	BG3	5.0	6.5	8.0	dB	f=50Hz, V_{IN}=−60dBv, B.B-MID
Total harmonic distortion	THDB	—	0.3	1.0	%	f=1kHz, V_{IN}=−40dBv, 30kHz LPF
Ripple leak	RLB	—	−82.5	−75.0	dBv	+B=1.0V+(−26dBv), f=130Hz Vcc=2.0V+(−20dBv), f=130Hz Rg=600Ω, 130Hz BPF+DIN-AUDIO

* This is the amount of boost in relation to a gain of 1kHz, when the secondary LPF (low-pass filter) is attached as specified by the measurement circuit example.
** This is the amount of boost in relation to a gain of 1kHz, when the HPF (high-pass filter) is attached as specified by the measurement circuit example.

(unless otherwise noted, ＋B = 1.3V, V_{CC} = 2.3V, f = 1kHz, PreOutR_L = 5kΩ(OCL), PWROutR_L = 16Ω (OCL), Ta = 25°C)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Coniditions
〈AVLS〉						
AVLS suppression level	AV_O	−44.0	−41.0	−40.0	dBv	V_{IN}=−30dBv Rav=6.8kΩ, R_L=16Ω
AVLS start input level	AV_{IN}	−67.8	−64.8	−61.8	dBv	V_{IN}=−64.8dBv Rav=6.8kΩ, R_L=16Ω
AVLS distortion	AVTHD	−	0.4	1.5	%	V_{IN}=−20dBv, B.B-OFF Rav=6.8kΩ, R_L=16Ω
BEEP output level	VBeep	−61	−58	−55	dBv	R_L=16Ω, IBeep=5μA$_{O-P}$ f=1kHz

Conditions applied to control pins
(Unless otherwise noted, +B = 0.9V, V_{CC} = 1.7V, f = 1kHz, PreOutR_L = 5kΩ ,PWROutR_L = 16Ω (OCL), Ta = 25°C)

Parameter		Symbol	Min.	Typ.	Max.	Unit	Coniditions
〈Pre block〉							
Tuner / TC	Tuner	SW1	0.77	—	7.0	V	HIGH
	TC		−0.2	—	0.4	V	LOW / OPEN
	I_{SWIN}		4	9	15	μA	V11pin=0.77V
FWD / REV	FWD	SW2	0.65	—	7.0	V	HIGH / OPEN
	REV		−0.2	—	0.2	V	LOW
	I_{SWOUT}		0.5	2.3	3.5	μA	V13pin=0.2V
MTL / NOR	MTL	SW3	0.7	—	7.0	V	HIGH / OPEN
	NOR		−0.2	—	0.2	V	LOW
	I_{SWOUT}		0.5	2.3	3.5	μA	V42pin=0.2V
〈Power block〉							
PWR ON / OFF	ON	SW4	0.77	—	7.0	V	HIGH
	OFF		−0.2	—	0.4	V	LOW / OPEN
	I_{SWIN}		5	11	17	μA	V12pin=0.77V
MUTE ON / OFF	OFF	SW5	0.65	—	7.0	V	HIGH
	ON		−0.2	—	0.2	V	LOW
	I_{SWIN}		—	0.25	1.0	μA	V10pin=0.65V
B.B ON / OFF	ON	SW6	0.75	—	7.0	V	HIGH
	OFF		−0.2	—	0.3	V	LOW
	I_{SWOUT}		—	0.0	1.0	μA	V9pin=0.3V
	I_{SWIN1}		—	0.0	1.0	μA	V9pin=1.5V, V10pin=0.6V
	I_{SWIN2}		3	7	11	μA	V10pin=0V
AVLS ON / OFF	ON	SW7	—	—	—	V	PWR1 and PWR2 signals input
	OFF		−0.2	—	0.2	V	LOW
	I_{SWOUT}		5	25	30	μA	V47pin=0.2V
B.B MAX / MID	MAX	SW8	0.65	—	7.0	V	HIGH / OPEN
	MID		−0.2	—	0.2	V	LOW
	I_{SWOUT}		0.5	2.3	3.5	μA	V8pin=0.2V

I_{SWIN} : Indicates current flowing to the interior of the IC.
I_{SWOUT}: Indicates current flowing to the exterior of the IC.

●Measurement circuit

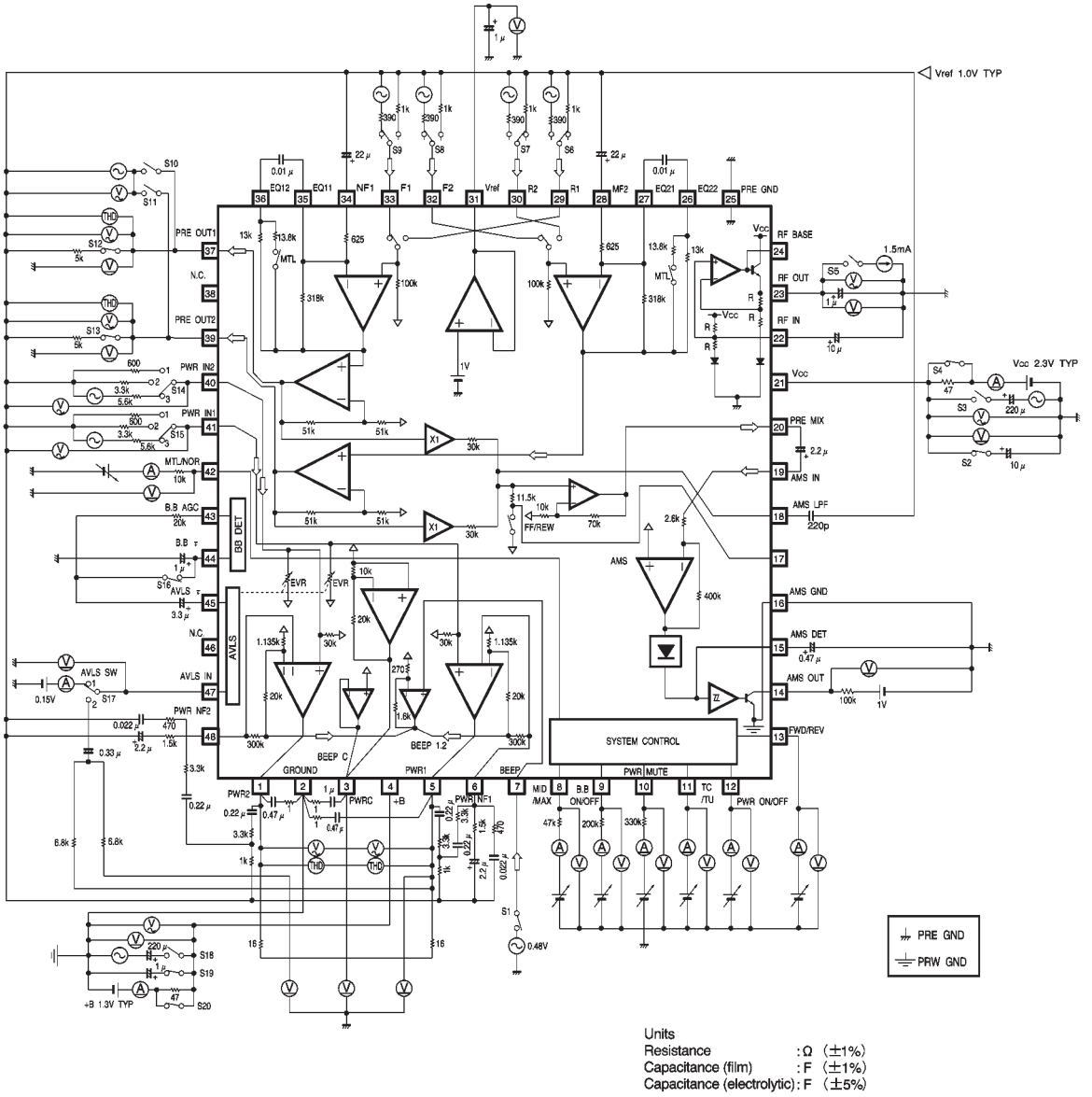


Fig.1

●Electrical characteristic curves

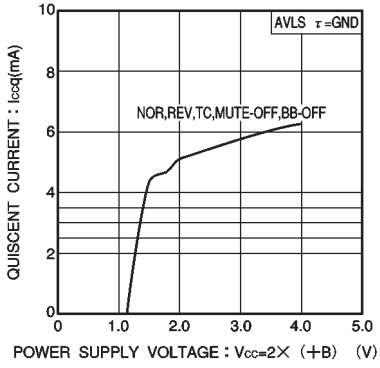


Fig.2 Quiescent current vs. power supply voltage

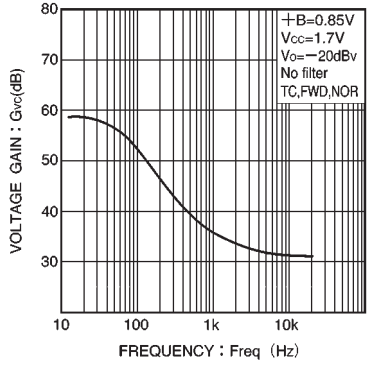


Fig.3 PRE gain vs. frequency

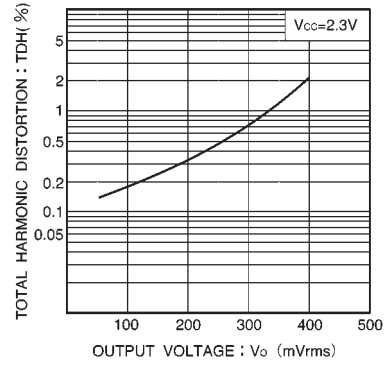


Fig.4 Total harmonic distortion

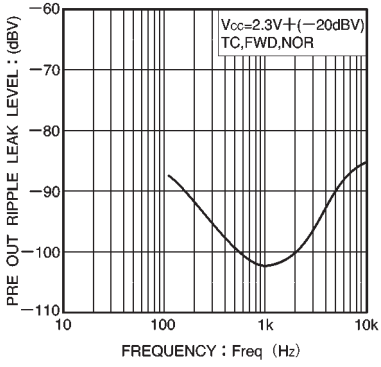


Fig.5 PRE ripple leak characteristics

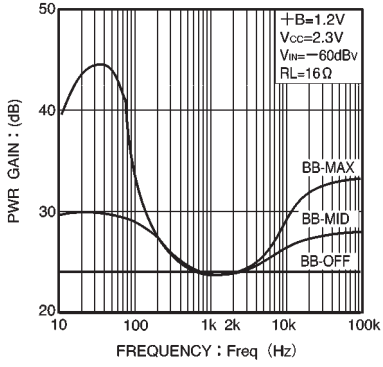


Fig.6 PWR gain vs. frequency

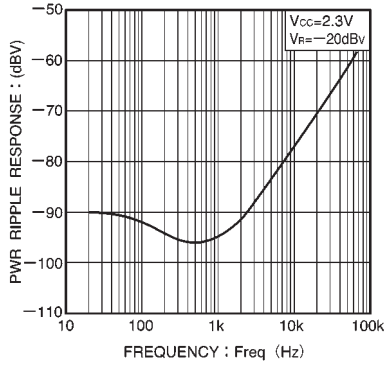


Fig.7 PWR ripple leak characteristics

●External dimensions (Units: mm)