IC for Headphone Stereos (bass boost)
Monolithic IC LAG 668

Outline

This IC was developed to provide bass boost functions without deviating from the basic design concept of Mitsumi's LAG665, which is highly regarded for applications in headphone stereos for overseas markets in particular.

Bass boost functions are widely adopted in models for overseas markets as well. However, because of stringent cost constraints, there has been a need for an IC which is simple and inexpensive. This IC can provide bass boost functions simply by adding three resistors and one capacitor (per channel).

Moreover, it has the same pinout as the LAG665, so that by making selective use of set features, a product lineup can be developed without changes to the printed circuit board.

Features

1. Configuration: pre and power amps, motor control, E. VR, bass boost
2. Preamp off function convenient for use in models with radios
3. Independent motor control circuit
    1. Motor noise is effectively suppressed
    2. With motor on/off pin (motor can be stopped easily when radio is in use)
    3. With fast forward pin
4. Bass boost frequency characteristic can be changed simply by changing the resistance multiplier.
5. Well-balanced E. VR circuit
    1. L, R channels variable using a single VR
    2. A-curve can be reproduced using B-curve VR
6. Few external components

Package

SOP-28B (LAG668F)
SDIP-30A (LAG668D)

Absolute Maximum Ratings

Item	Symbol	Ratings	Units
Operating temperature	T_{OPR}	−20~+65	℃
Storage temperature	T_{STG}	−40~+125	℃
Power supply current	V_{CC} max.	−0.3~+7.5	V
Power consumption	Pd	DIP : 750, SOP : 450	mW
Operating voltage	Vop	+2.0~+5.0	V

Electrical Characteristics (Except where noted otherwise, Ta=25℃)

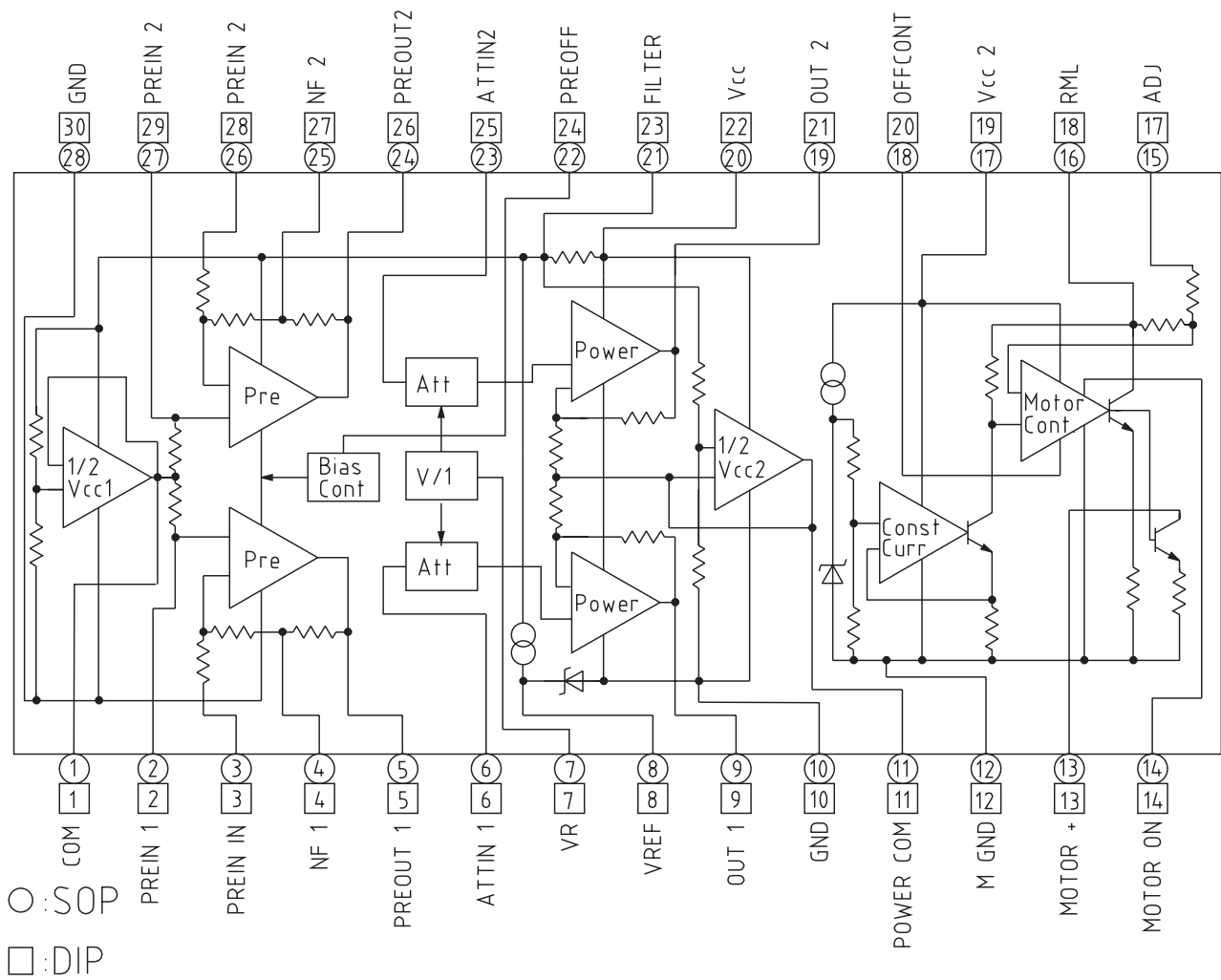| Item	Symbol	Measurement conditions	Min.	Typ.	Max.	Units
Consumption current	I_{CC}	V_{IN}=0v, IM=0mA		18	25	mA
Preamp unit (Ta=25℃)						
Open-circuit gain	Gvo	V_O=−10dBm, R_L=infinite		72		dB
Closed-circuit gain	Gvc	V_O=−10dBm	40	42	44	dB
Maximum output voltage	Vom	THD=10%	0.45	0.6		Vrms
Total harmonic distortion ratio	THD	V_{OUT}=400mVrms		0.05	0.5	%
Output noise voltage	Vno	V_{IN}=0, Rg=2.2k, BPF (30~20kHz)		150	300	µVrms
Input impedance	Z_{IN}	V_{OUT}=−10dBm	18	22		kΩ
Crosstalk between channels	C.T	Rg=2.2k, V_{OUT}=−10dBm	30			dB
Output voltage with pre off	Vooff	V_{IN}=100mVrms			−50	dB
Output resistance with pre off	Rooff			10		kΩ
Input resistance on pre off	Rioff			10		kΩ
Attenuator unit (Ta=25℃)						
Maximum input voltage	Vi max.		0.2			Vrms
Maximum attenuation	Va max.	Vcont=min.	66			dB
Attenuation error	Vaerr	Vcont=max.		0		dB
Input impedance	Z_{IN}		200			kΩ
Control pin input resistance	Zicot		100			kΩ
Power amp unit (Ta=25℃)						
Voltage gain	Gv	P_{OUT}=5mW	36	38	40	dB
Voltage gain difference between channels	⌀Gv	Vcont=max.		0	3	dB
Maximum output power I	Pom1	THD=10%, R_L=32Ω	20	28		mW
Maximum output power II	Pom2	THD=10%, R_L=16Ω	30			mW
Total harmonic distortion ratio	THD	P_{OUT}=5mW		0.5	2.0	%
Crosstalk between channels	C.T	P_{OUT}=5mW	20	30		dB
Output noise voltage	Vn	Rg=2.2k, Vcont=max.		1.0	2.0	mVrms
Ripple rejection	RR	V_{CC}=3V, 100Hz, 100mVp−p	31	37		dB
Noise of preamp + power amp + B.B.	Vnto	V_{IN}=0, Rg=2.2k, Vcont=max. ＊1		3.0	6.0	mVrms
Motor control unit (Ta=25℃)						
Consumption current	IMC			3.0	5.0	mA
Startup current	IMS		500			mA
Reference voltage	Vref	Between RML–ADJ pins	0.72	0.80	0.87	V
Reference voltage fluctuation I	Vref1	V_{CC} between 2.1 and 5.0 V		0.05		%/V
Reference voltage fluctuation II	Vref2	I_M between 25 and 250 mA		0.01		%/mA
Reference voltage fluctuation III	Vref3	Ta between −10 and 50℃		0.01		%/℃
Current coefficient	K		32	38	43	
Current coefficient fluctuation I	K1	V_{CC} between 2.1 and 5.0 V		0.5		%/V
Current coefficient fluctuation II	K2	I_M between 25 and 250 mA		0.05		%/mA
Current coefficient fluctuation III	K3	Ta between −10 and 50℃		0.02		%/℃
Output voltage on forced on	VCEsa	I_M=200mA, 14PIN=V_{CC}			0.6	V
Input resistance on forced on	Rion			5.6		kΩ
Leakage current on forced off	IML				200	µA
Input resistance on forced off	Ricon			33		kΩ

＊Conditions unless stated otherwise
　　Amp unit: V_{CC}=3.0V, f=1kHz, R_L=16Ω, Pre OFF=OPEN
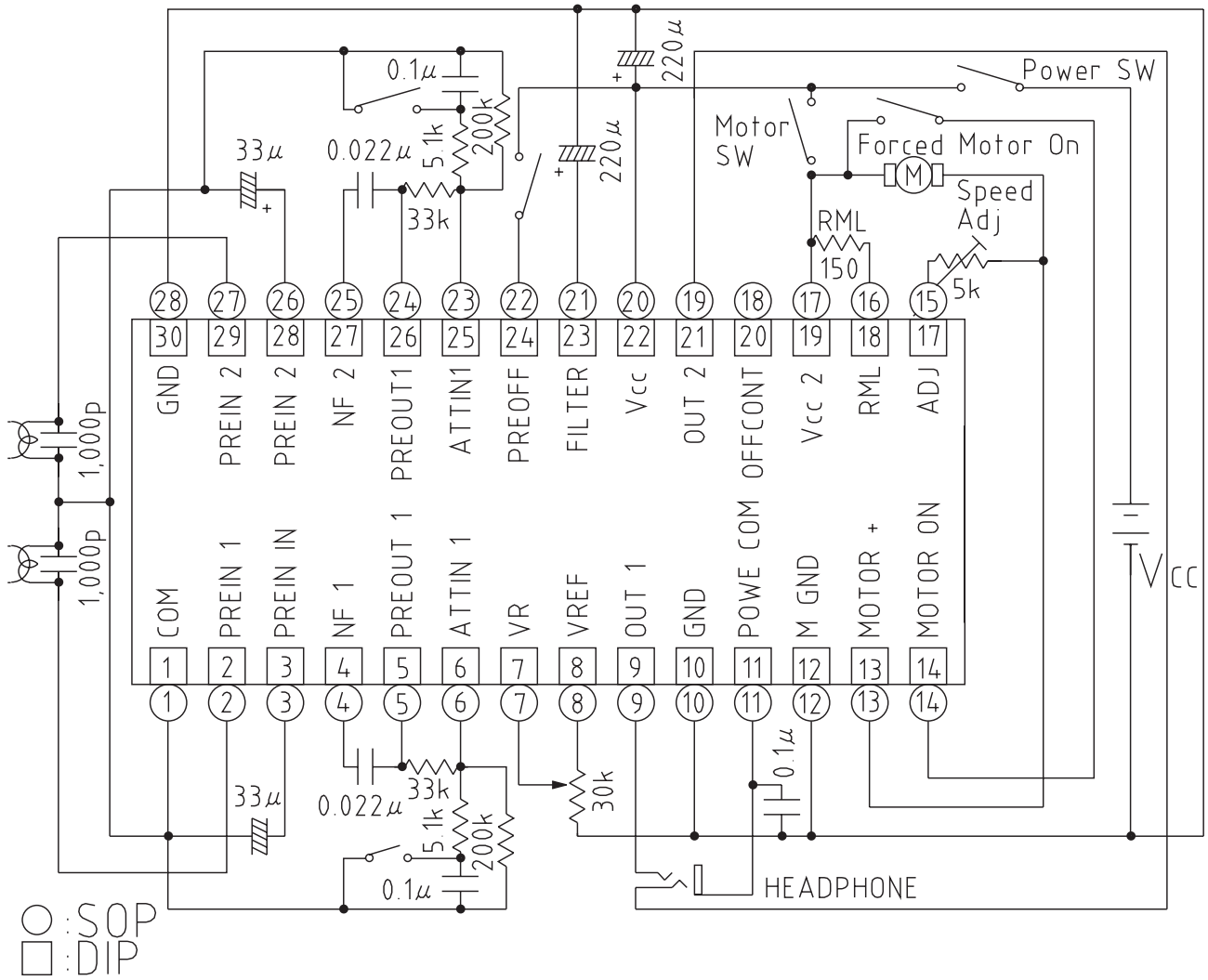　　Motor unit: V_{CC}=3.0V, I_M=100mA, Motor unit: (Mitsumi model)
Note 1: Bass boost circuit constants are based on application circuit diagrams.
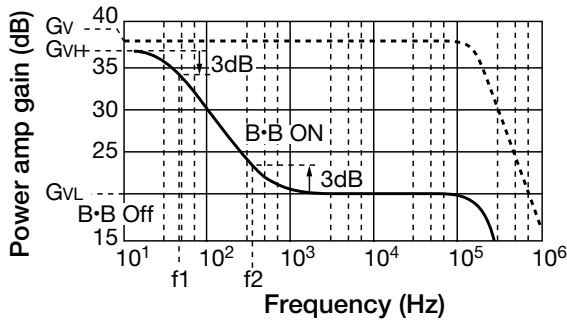Note 2: Motor pin voltage fluctuations

Block Diagram

Application Circuits

0.1μ
33μ 0.022μ 5.1k 200k
33k
220μ 220μ
Power SW
Motor SW
Forced Motor On
Speed Adj
RML 150
5k

Pin numbers (SOP / DIP):

○	28	27	26	25	24	23	22	21	20	19	18	17	16	15
□	30	29	28	27	26	25	24	23	22	21	20	19	18	17
	GND	PREIN 2	PREIN 2	NF 2	PREOUT1	ATTIN1	PREOFF	FILTER	Vcc	OUT 2	OFFCONT	Vcc 2	RML	ADJ

	COM	PREIN 1	PREIN IN	NF 1	PREOUT 1	ATTIN 1	VR	VREF	OUT 1	GND	POWE COM	M GND	MOTOR +	MOTOR ON
□	1	2	3	4	5	6	7	8	9	10	11	12	13	14
○	1	2	3	4	5	6	7	8	9	10	11	12	13	14

1,000p 1,000p
33μ 0.022μ 33k 5.1k 200k 30k
0.1μ 0.1μ
HEADPHONE
Vcc

○ : SOP
□ : DIP

Bass Boost Power Amp Gain

Power amp gain (dB) vs Frequency (Hz)

Gv 40
GvH 35
30
25
GvL
B·B Off 15

+3dB
B·B ON
+3dB

10^1 10^2 10^3 10^4 10^5 10^6
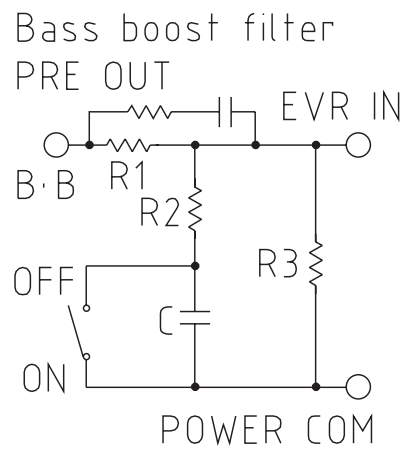f1 f2

Gv : Power amp gain

GvH : Bass boost power amp gain (high level)

GvL : Bass boost power amp gain (low level, or boost off)

f1, f2: Cutoff frequencies

$$G_{VH} = G_V + 20\,\mathrm{Log}\left(\frac{R3}{R1+R3}\right)\ (\mathrm{dB})$$

$$G_{VL} = G_V + 20\,\mathrm{Log}\left(\frac{R2//R3 \times R1}{R2//R3 + R1}\right)\ (\mathrm{dB})$$

$$f1 = \frac{1}{2\pi\,((R_1//R_3) + R_2)C}\ (\mathrm{Hz})$$

$$f2 = \frac{1}{2\pi R_2 C}\ (\mathrm{Hz})$$

Bass boost filter
PRE OUT
EVR IN
B·B R1 R2 R3
OFF
C
ON
POWER COM

Characteristics (Bass boost)

■ Recommended constants

R1=33kΩ GVH=37dB

R2=4.7kΩ GVL=20dB

R3=180kΩ f1=50Hz

C=0.1μF f2=340Hz

No R4 or C2

■ Bass boost efficiency

R1=12kΩ GVH=37dB

R2=2.2kΩ GVL=20dB

R3=180kΩ f1=130Hz

C=0.1μF f2=720Hz

No R4 or C2
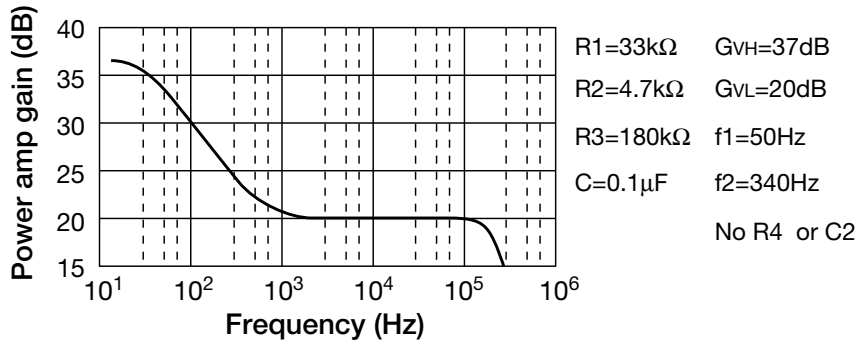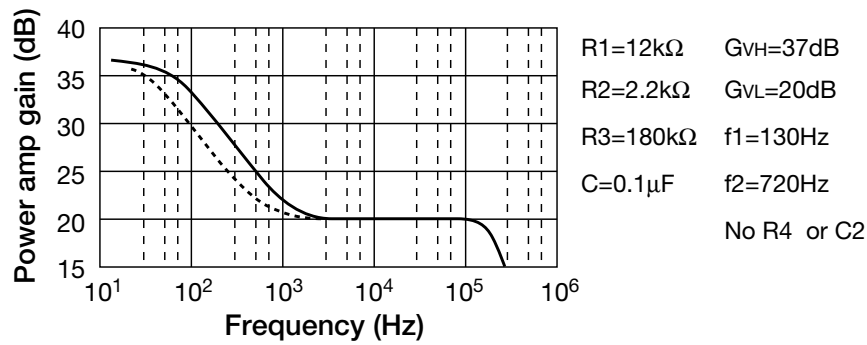
■ Response for poor headphone and cassette head characteristics

R1=33kΩ GVH=37dB

R2=6.8kΩ GVL=23dB

R3=180kΩ f1=50Hz

C=0.1μF f2=230Hz

No R4 or C2

■ Bass + treble boost

R1=33kΩ GVH=37dB

R2=4.7kΩ GVL=20dB

R3=180kΩ f1=50Hz

C=0.1μF f2=340Hz

R4=20kΩ GVH=27dB

C2=390pF