

Audio sound controller

BH3864F

The BH3864F has been developed for use in mini-component stereo systems. Switching is done using a resistor ladder to suppress DC offset at switching. Two-line serial control is available, and external three-line serial control is also possible. The package is a compact 24-pin SOP.

●Applications

Mini- and micro-component stereo systems, CD radio cassette players and TVs.

●Features

- 1) Volume, tone, and dynamic bass boost control possible by a serial link to a microprocessor.
- 2) Left and right channel volume can be controlled independently.
- 3) Resistor-ladder type volume control uses BiCMOS process for low distortion and noise.
- 4) Dynamic bass and linked ALC are provided on chip.

●Absolute maximum ratings (Ta = 25°C)

Parameter	Symbol	Limits	Unit
Applied voltage	Vcc	-0.3~10.0	V
Power dissipation	Pd	550 *	mW
Operating temperature	Topr	-40~+85	°C
Storage temperature	Tstg	-55~+125	°C

* Reduced by 5.5mW for each increase in Ta of 1°C over 25°C when mounted on a 50mm x 50mm x 1.6mm board.

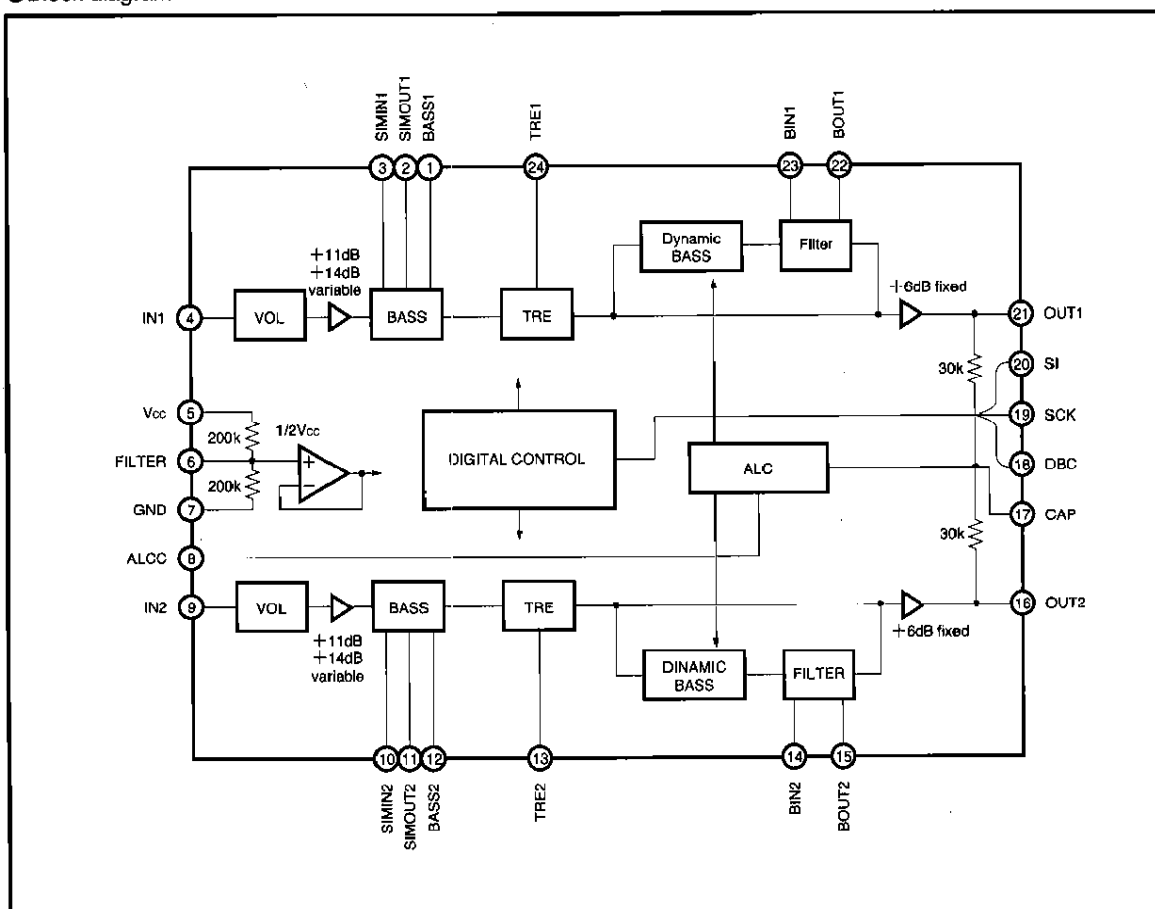
●Recommended operating conditions (Ta = 25°C)

Parameter	Symbol	Min.	Typ.	Max.	Unit
Supply voltage	Vcc	7.0	9.0	9.5	V

Sound control

Audio accessory components

● Block diagram



● Pin descriptions

Pin No.	Symbol	Function
1	BASS1	Channel 1 bass filter setting terminal
2	SIMOUT1	Channel 1 bass filter setting terminal
3	SIMIN1	Channel 1 bass filter setting terminal
4	IN1	Channel 1 signal input terminal
5	Vcc	Power supply terminal
6	FILTER	Filter terminal
7	GND	Ground terminal
8	ALCC	ALC attack and release time setting terminal
9	IN2	Channel 2 signal input terminal
10	SIMIN2	Channel 2 bass filter setting terminal
11	SIMOUT2	Channel 2 bass filter setting terminal
12	BASS2	Channel 2 bass filter setting terminal

Pin No.	Symbol	Function
13	TRE2	Channel 2 treble filter setting terminal
14	BIN2	Channel 2 dynamic bass filter setting terminal
15	BOUT2	Channel 2 dynamic bass filter setting terminal
16	OUT2	Channel 2 signal output terminal
17	CAP	ALC trap frequency setting terminal
18	DBC	Dynamic bass switch retiming setting terminal
19	SCK	Serial clock input terminal
20	SI	Serial data input terminal
21	OUT1	Channel 1 signal output terminal
22	BOUT1	Channel 1 dynamic bass filter setting terminal
23	BIN1	Channel 1 dynamic bass filter setting terminal
24	TRE1	Channel 1 treble filter setting terminal

● Electrical characteristics (Unless otherwise specified, $T_a = 25^\circ\text{C}$, $V_{cc} = 9\text{V}$, $f = 1\text{kHz}$, $R_g = 600\ \Omega$, $R_L = 10\text{k}\Omega$, $BW = 20\text{Hz}$ to 20kHz , $V_{IN} = 200\text{mVrms}$, volume = 0dB , tone = 0dB , dynamic bass = 0dB , and gain select = 14dB)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
Quiescent current	I_Q	—	11	22	mA	$V_{IN}=0\text{Vrms}$
Maximum input voltage	V_{IM}	2.2	2.5	—	Vrms	ATT = -30dB , output THD = 1%
Maximum output voltage	V_{OM}	2.2	2.5	—	Vrms	Output THD = 1%, BW = 400Hz to 30kHz
Voltage gain	GV	18	20	22	dB	
Total harmonic distortion	THD	—	0.01	0.05	%	$V_o=1\text{Vrms}$
Output noise conversion voltage	V_{NO}	—	25	40	μVrms	$R_g=0\ \Omega$ *
Residual noise voltage	V_{MNO}	—	25	40	μVrms	Volume = $-\infty$ *
Crosstalk	CT	—	94	60	dB	
Channel balance	CB	-1.5	0	1.5	dB	CH1 standard measuring
Input impedance	R_{IN1}	7.5	9.4	11.3	k Ω	
Input impedance	R_{IN2}	10.6	13.3	16.0	k Ω	ATT = -3dB (-45dB)
Ripple rejection	RR	—	-40	-35	dB	$f_{RR}=100\text{Hz}$, $V_{RRIN}=100\text{mVrms}$
Volume step resolution	AT_{STEP}	—	1	—	dB	
Maximum volume attenuation	AT_{MIN}	-80	-94	—	dB	
Volume step error	AT_{ERR}	—	0	—	dB	
Bass control range	VB	± 8.5	± 10.5	± 12.5	dB	
Treble control range	VT	± 8	± 10	± 12	dB	
Tone step resolution	V_{STEP}	—	2	—	dB	
Dynamic bass control range	VDB	18	20	22	dB	$f=60\text{Hz}$, $V_{IN}=10\text{mVrms}$
Dynamic bass step resolution	VD_{STEP}	—	5	—	dB	
Current from logic terminals when "L"	I_D	—	1	10	μA	

* Measured using a Matsushita Communication Industry VP-9690A (average value detector, effective value display) IHF-A filter.

Operating specifications: same phase for the input and output signals.

©Circuit not designed for radiation resistance.

Sound control

Audio accessory components

● Measurement circuit

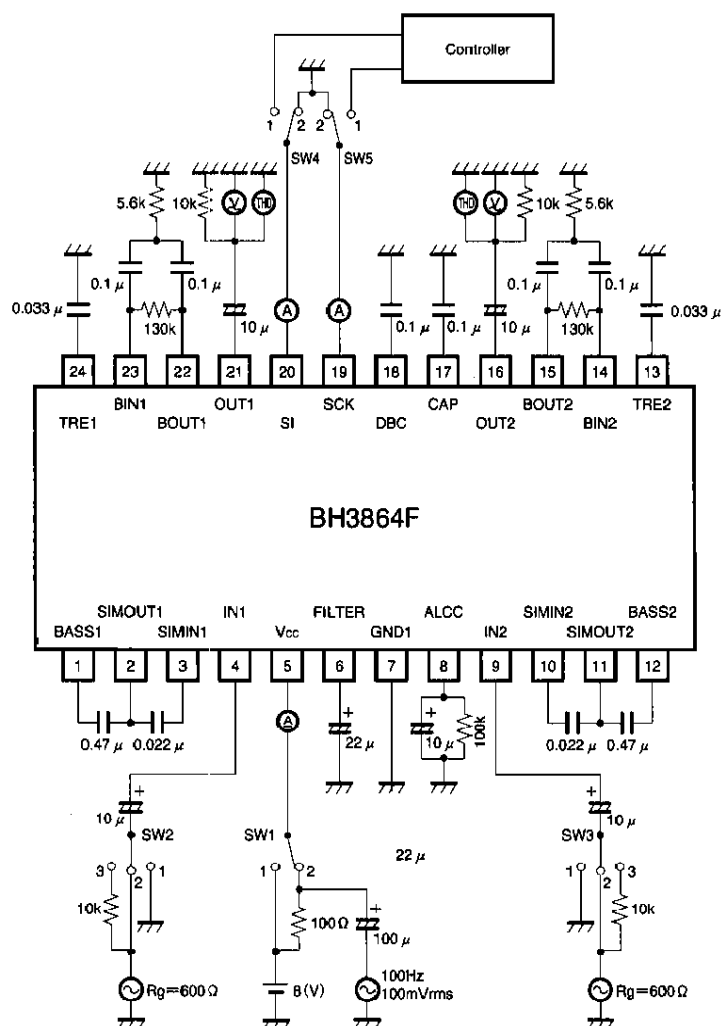


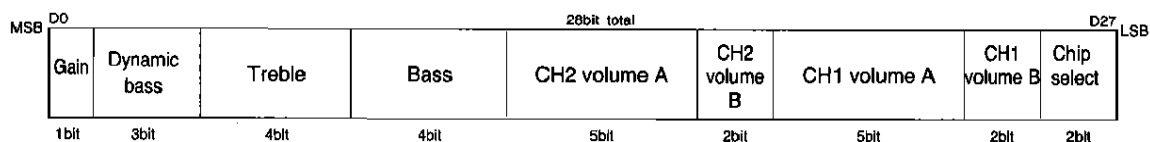
Fig. 1

● Circuit operation

(1) About the data format

As shown in Fig. 2, there are 28 bits of data.

There are two chip select bits, but multiple units cannot be controlled by a single controller.



(2) SCK and SI signal timing

The SCK and SI signal timing are shown in Fig. 3. The SI signal potential level decision is made internally. A Schmitt trigger circuit on the chip is used to provide noise margin. The internal circuits are bipolar, so take care with regard to source current.

The data is read in on the rising edge of the clock.

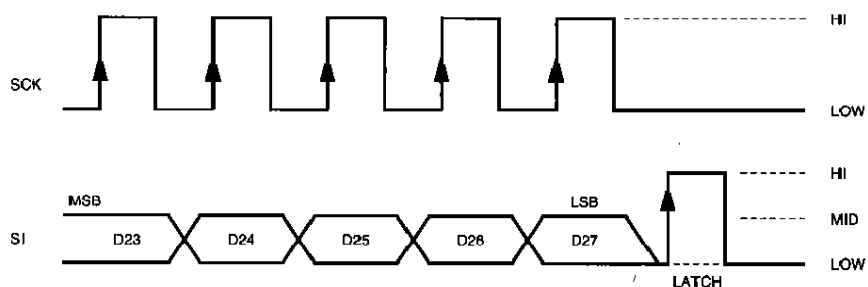


Fig. 3

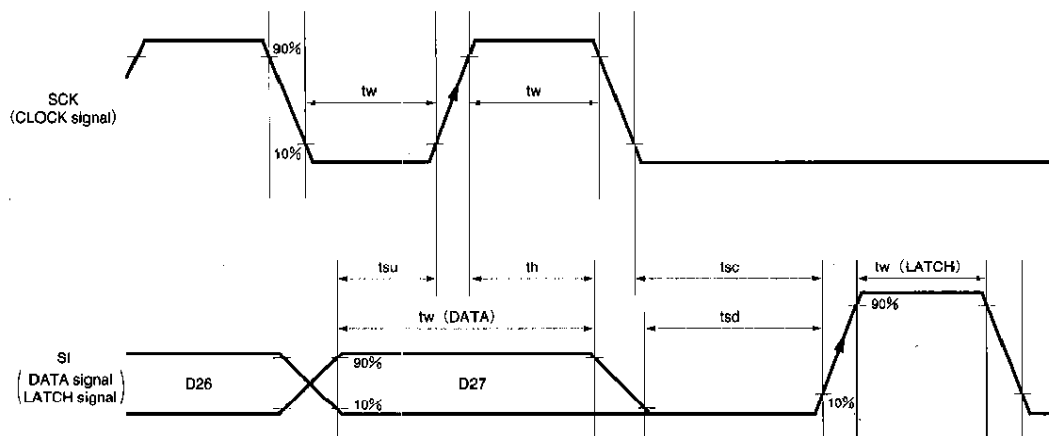
Sound control

Audio accessory components

(3) Timing chart

The timing chart is shown in Fig. 4.

Serial data timing



* When SI is "H", the DATA signal is forced "L" internally, and data is not accepted.

Fig. 4

Timing chart constants ($T_a = 25^\circ\text{C}$, $V_{CC} = 9\text{V}$)

Parameter	Symbol	Min.	Typ.	Max.	Unit
H input voltage	V_{IH}	4.0	5.0	6.0	V
M input voltage	V_{IM}	2.0	2.5	3.0	V
L input voltage	V_{IL}	-0.3	0	1.0	V
Minimum clock width	t_w	2.0	—	—	μS
Minimum data width	$t_w(\text{DATA})$	4.0	—	—	μS
Minimum latch width	$t_w(\text{LATCH})$	2.0	—	—	μS
Setup time (DATA to CLK)	t_{su}	1.0	—	—	μS
Hold time (CLK to DATA)	t_h	1.0	—	—	μS
Setup time (CLK to LATCH)	t_{sc}	1.0	—	—	μS
Setup time (DATA to LATCH)	t_{sd}	1.0	—	—	μS

(4) Data table

The transmission data is given in the table below.

VOLUME ATTENUATION

Volume A

GAIN	CH1	D19	D20	D21	D22	D23
	CH2	D12	D13	D14	D15	D16
0dB		0	0	0	0	0
-2dB		0	0	0	0	1
-4dB		0	0	0	1	0
-6dB		0	0	0	1	1
-8dB		0	0	1	0	0
-10dB		0	0	1	0	1
-12dB		0	0	1	1	0
-14dB		0	0	1	1	1
-16dB		0	1	0	0	0
-18dB		0	1	0	0	1
-20dB		0	1	0	1	0
-22dB		0	1	0	1	1
-24dB		0	1	1	0	0
-26dB		0	1	1	0	1
-28dB		0	1	1	1	0
-30dB		0	1	1	1	1
-32dB		1	0	0	0	0
-34dB		1	0	0	0	1
-36dB		1	0	0	1	0
-38dB		1	0	0	1	1
-40dB		1	0	1	0	0
-42dB		1	0	1	0	1
-46dB		1	0	1	1	0
-50dB		1	0	1	1	1
-54dB		1	1	0	0	0
-58dB		1	1	0	0	1
-62dB		1	1	0	1	0
-66dB		1	1	0	1	1
-70dB		1	1	1	0	0
-74dB		1	1	1	0	1
-78dB		1	1	1	1	0
-∞		1	1	1	1	1

Sound control

Audio accessory components

Volume B

GAIN	CH1	D24	D25
	CH2	D17	D18
0dB		0	0
-1dB		0	1
-2dB		1	0
-3dB		1	1

(The -2dB and -3dB settings)
operate when the setting is
-42dB or lower.

By combining volume A and B, it is possible to provide control from 0dB to -81dB in 1dB steps.

BASS AND TREBLE (TONE CONTROL)

GAIN	BASS			
	D4	D5	D6	D7
+10.5dB	1	1	0	1
+8dB	1	1	0	0
+6dB	1	0	1	1
+4dB	1	0	1	0
+2dB	1	0	0	1
0dB	1	0	0	0
0dB	0	0	0	0
-2dB	0	0	0	1
-4dB	0	0	1	0
-6dB	0	0	1	1
-8dB	0	1	0	0
-10.5dB	0	1	0	1

GAIN	TREBLE			
	D8	D9	D10	D11
+10dB	1	1	0	1
+8dB	1	1	0	0
+6dB	1	0	1	1
+4dB	1	0	1	0
+2dB	1	0	0	1
0dB	1	0	0	0
0dB	0	0	0	0
-2dB	0	0	0	1
-4dB	0	0	1	0
-6dB	0	0	1	1
-8dB	0	1	0	0
-10dB	0	1	0	1

Note: Gain is the name given to the transfer data. Depending on the values of the external components, the specified gain may not be output.

DYNAMIC BASS BOOST

GAIN	D1	D2	D3
0dB	0	0	0
5dB	0	0	1
10dB	0	1	0
15dB	0	1	1
20dB	1	0	0

Note: Gain is the name given to the transfer data. Depending on the values of the external components, the specified gain may not be output.

CHIP SELECT

D26	D27
1	1

Note: For all other data, the previous data are maintained.

GAIN SELECT

INPUT AMP GAIN	D0
11dB	1
14dB	0

●Application example

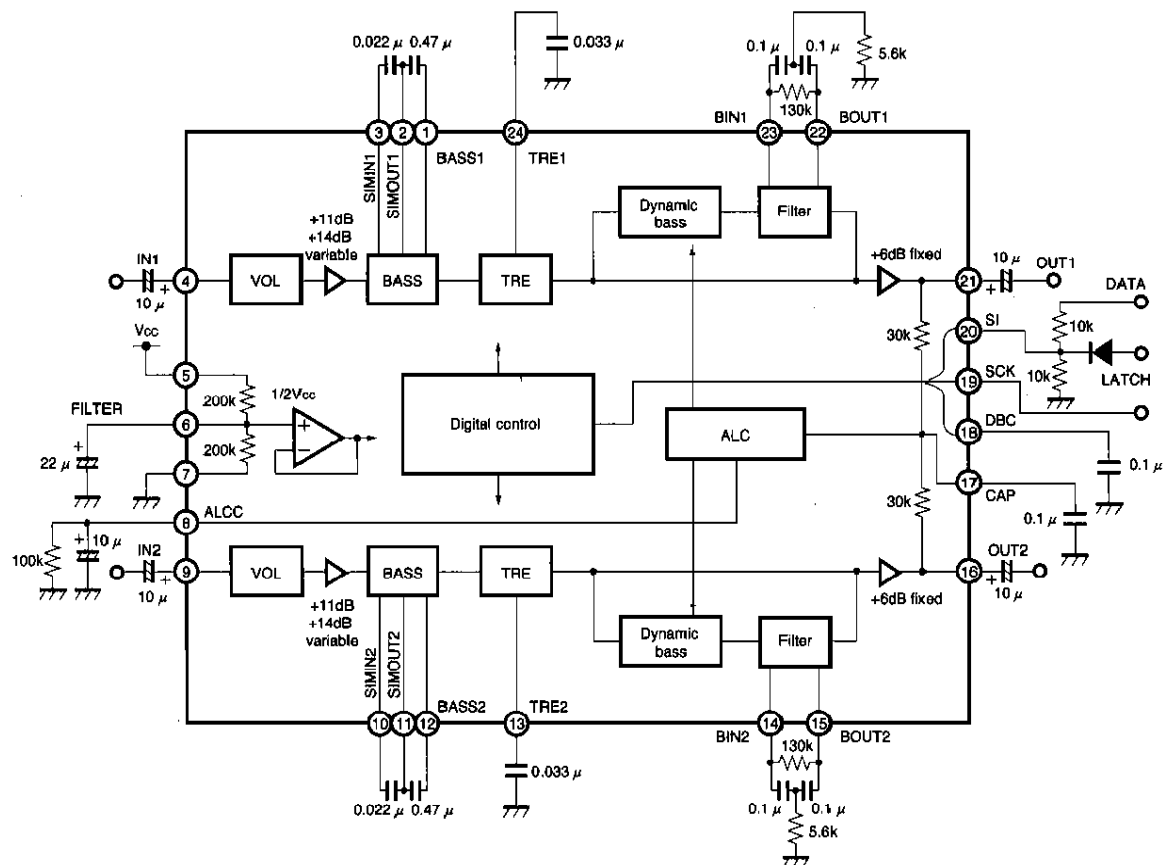


Fig. 5

● External components

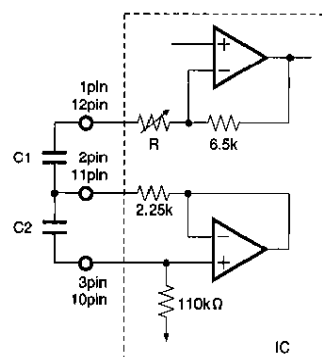
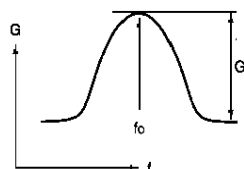
(1) Tone control filter constants

Bass region

$$f_0 = \frac{1}{2\pi \sqrt{110k \times 2.25k \times C_1 \times C_2}} \quad (\text{Hz})$$

$$Q = \sqrt{\frac{110k \times C_2}{2.25k \times C_1}}$$

$$G = 20 \log \left(\frac{2.25k + R + 6.5k}{2.25k + R} \right) \quad (\text{dB})$$



Equivalent circuit diagram

Note: The variables C_1 , C_2 and R in the formulas are the components in the equivalent circuit.

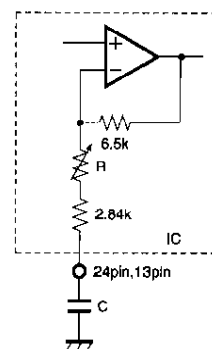
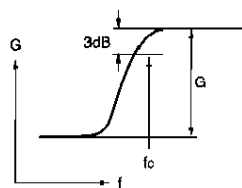
Bass control data	$R(k\Omega)$
$\pm 10.5\text{dB}$	0
$\pm 8\text{dB}$	1.95
$\pm 6\text{dB}$	4.5
$\pm 4\text{dB}$	9.0
$\pm 2\text{dB}$	23.0
$\pm 0\text{dB}$	∞

The actual gain may vary somewhat.

Treble

$$f_c = \frac{1}{2\pi \times 2.84k \times C} \quad (\text{Hz})$$

$$G = 20 \log \left(\frac{2.84k + R + 6.5k}{2.84k + R} \right) \quad (\text{dB})$$



Equivalent circuit diagram

Note: The variables C and R in the formulas are the components in the equivalent circuit. The internally-fixed settings for R are as follows.

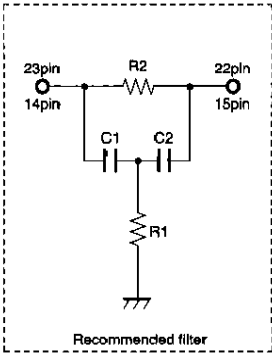
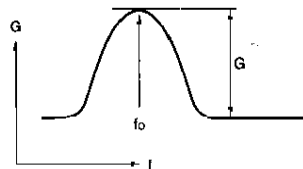
Treble control data	R(kΩ)
±10dB	0
±8dB	1.34
±6dB	3.6
±4dB	8.22
±2dB	22
±0dB	∞

The actual gain may vary somewhat.

(2) Dynamic bass filter constants

$f_0 = \frac{1}{2\pi\sqrt{R_1 \times R_2 \times C_1 \times C_2}}$ (Hz)

$G = 20 \log \left(1 + \frac{55g}{1+54t} \right)$ (dB)



Note: R₁, R₂, C₁ and C₂ are the recommended values for the filter. g is fixed internally (see the table below).

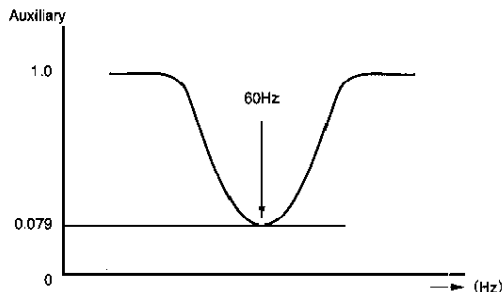
Dynamic bass control data	g
20dB	1
15dB	0.5
10dB	0.25
5dB	0.085
0dB	0

Constants in formulas

The variable "t" in the formula depends on the filter.
For the recommended filter, the relationship is as follows.

$$t = 1 - \frac{1}{1 + \frac{R_1}{R_2} \left(1 + \frac{C_1}{C_2}\right)}$$

For the application circuit example, $t = 0.079$.



Recommended filter characteristics

The actual gain may vary slightly.

(3) ALC (automatic level control)

1) Trap frequency T_f

The trap frequency T_f is obtained from the following formula.

$$T_f = \frac{1}{2\pi \times 10k \times C} \text{ (Hz)}$$

Note: C is the value of the capacitance between pin 17 and GND.

● Operation notes

We guarantee the application circuit design, but recommend that you thoroughly check its characteristics and pay attention to the points of caution given below. If you change any of the external component values, check both the static and transient characteristics of the circuit, and allow sufficient margin in your selections to take into account variations in the components and ICs.

(1) Supply voltage range

The basic circuit functions are guaranteed to operate if the circuit is operated within the recommended temperature and supply voltage ranges. Please confirm the values of the circuit constants, voltage setting, and temperature in actual use.

(2) Serial control

High-frequency digital signals are input to the SI and

2) Trap level

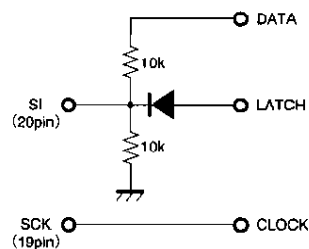
The signal level at which the ALC begins to operate depends on V_{CC} . The relationship is given below (T_L = trap level).

$$T_L = \frac{V_{CC}}{9} \text{ (Vrms)} \quad (\text{same phase input})$$

Note: It is possible to switch ALC off permanently by connecting pin 8 to GND.

SCK pins. Ensure that the wiring is done in such a way as to prevent interference with the analog signal lines. If noise is measured during step switching, connect resistors of about $2k\Omega$ in series with and close to the microprocessor outputs.

If you plan to use the conventional three-line serial method, we recommend that you used the following circuit (as shown in the application example circuit).



The diode should have as low a V_F as possible. Adjust the value of the resistors depending on the drive capacity of the microprocessor.

(3) Dynamic bass step switching noise

A capacitor is shown connected to DBC (pin 18) in the application circuit example. The value of this component varies with the signal level setting and PCB pattern. Investigate carefully before deciding on the values of the various circuit constants.

●Electrical characteristic curves

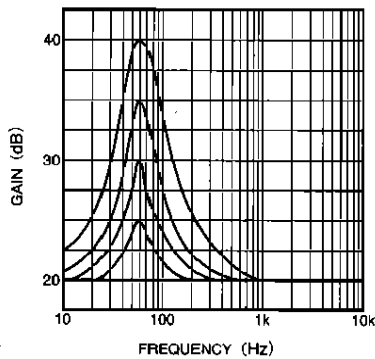


Fig. 6 Dynamic bass frequency characteristics

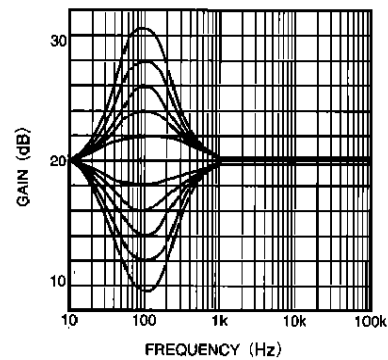


Fig. 7 Bass frequency characteristics

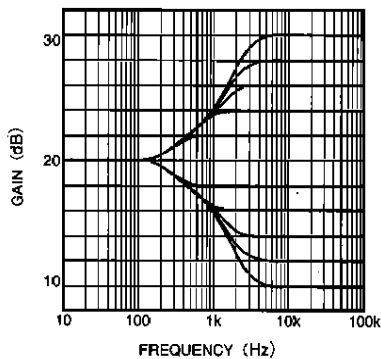


Fig. 8 Treble frequency characteristics

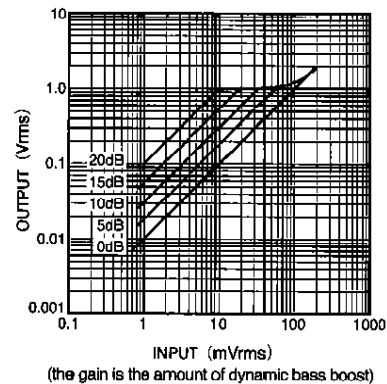
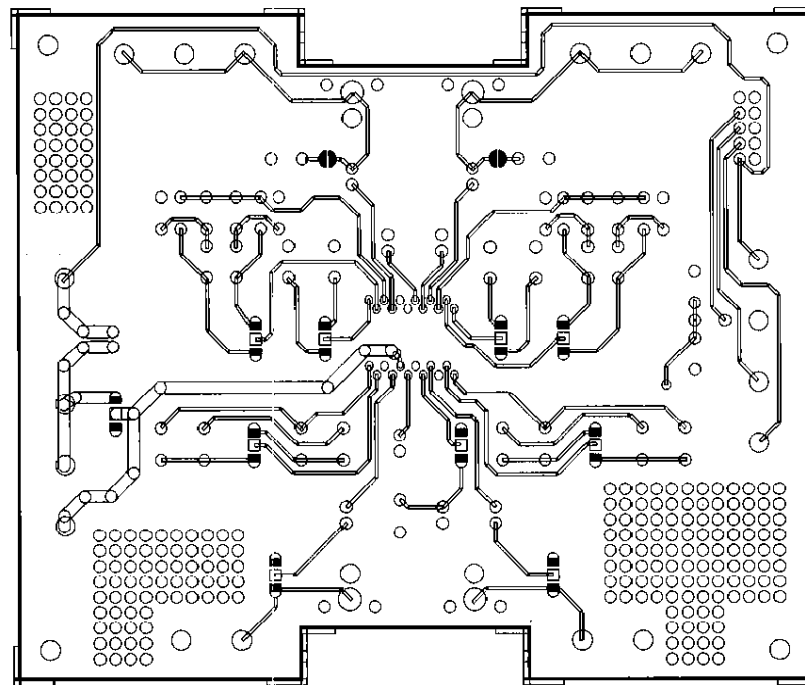
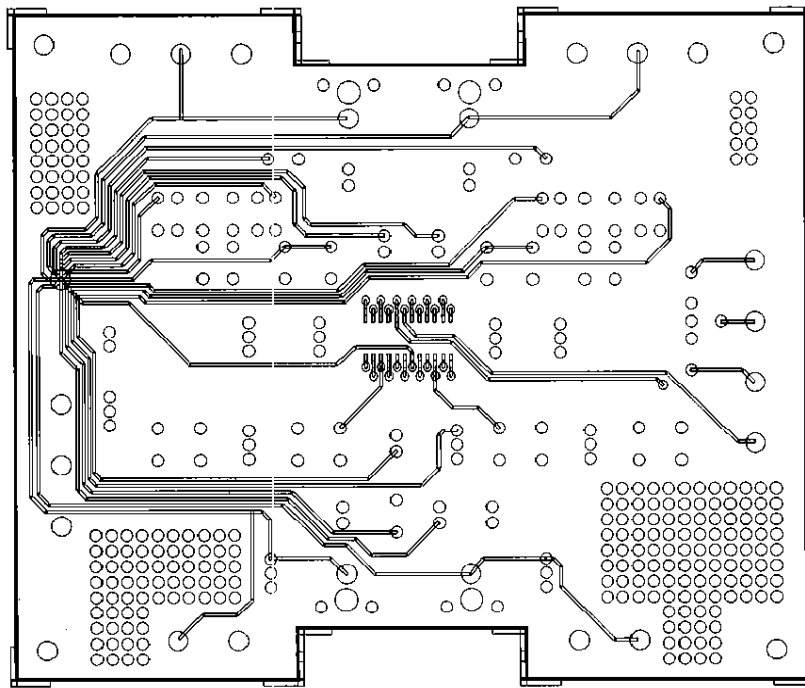


Fig. 9 ALC characteristics

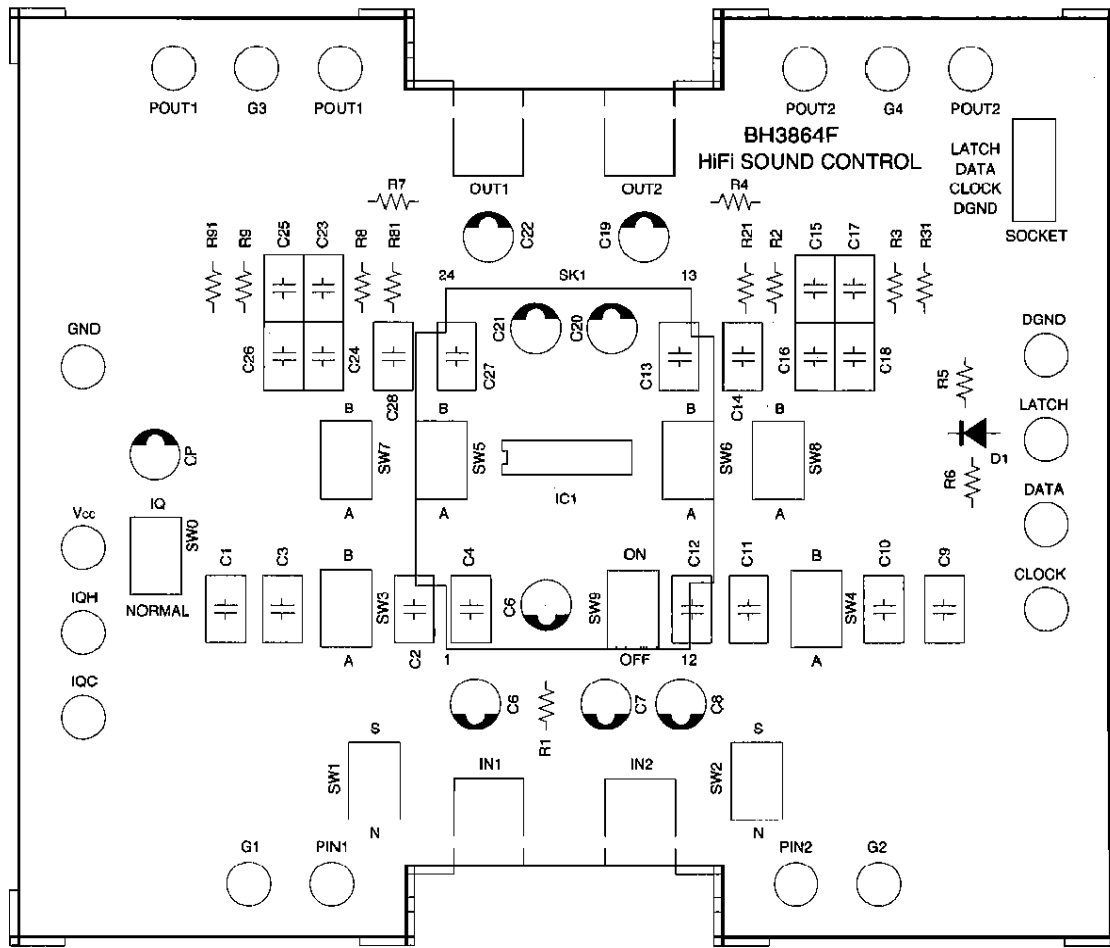
Sound control

Audio accessory components

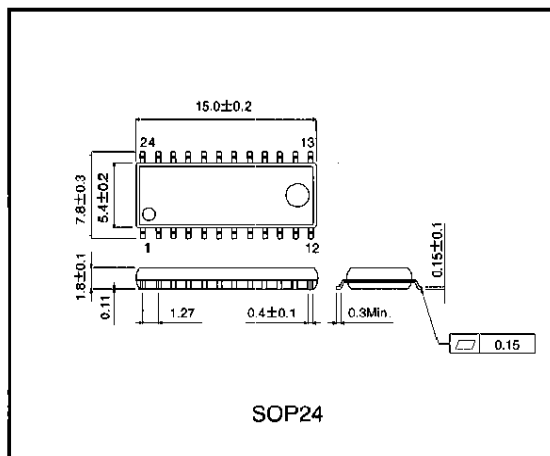
●Application example circuit PCB



●Application example circuit component layout



●External dimensions (Unit: mm)



Notes

- The contents described in this catalogue are correct as of March 1997.
- No unauthorized transmission or reproduction of this book, either in whole or in part, is permitted.
- The contents of this book are subject to change without notice. Always verify before use that the contents are the latest specifications. If, by any chance, a defect should arise in the equipment as a result of use without verification of the specifications, ROHM CO., LTD., can bear no responsibility whatsoever.
- Application circuit diagrams and circuit constants contained in this data book are shown as examples of standard use and operation. When designing for mass production, please pay careful attention to peripheral conditions.
- Any and all data, including, but not limited to application circuit diagrams, information, and various data, described in this catalogue are intended only as illustrations of such devices and not as the specifications for such devices. ROHM CO., LTD., disclaims any warranty that any use of such device shall be free from infringement of any third party's intellectual property rights or other proprietary rights, and further, assumes absolutely no liability in the event of any such infringement, or arising from or connected with or related to the use of such devices.
- Upon the sale of any such devices; other than for the buyer's right to use such devices itself, resell or otherwise dispose of the same; no express or implied right or license to practice or commercially exploit any intellectual property rights or other proprietary rights owned or controlled by ROHM CO., LTD., is granted to any such buyer.
- The products in this manual are manufactured with silicon as the main material.
- The products in this manual are not of radiation resistant design.

The products listed in this catalogue are designed to be used with ordinary electronic equipment or devices (such as audio-visual equipment, office-automation equipment, communications devices, electrical appliances, and electronic toys). Should you intend to use these products with equipment or devices which require an extremely high level of reliability and the malfunction of which would directly endanger human life (such as medical instruments, transportation equipment, aerospace machinery, nuclear-reactor controllers, fuel controllers, or other safety devices) please be sure to consult with our sales representatives in advance.

- Notes when exporting
 - It is essential to obtain export permission when exporting any of the above products when it falls under the category of strategic material (or labor) as determined by foreign exchange or foreign trade control laws.
 - Please be sure to consult with our sales representatives to ascertain whether any product is classified as a strategic material.