

VCR Hi-Fi audio signal processing system

BH7777AK

The BH7777AK is a HiFi audio signal processing system IC comprised of a peak-noise reduction (PNR) processor, an FM modulator/demodulator circuit, an input/output switch circuit, an automatic FM detector circuit, an FM band-pass filter, and a regulator circuit. The IC runs of a dual \pm power supply which allows a large reduction in the number of external components required.

●Applications

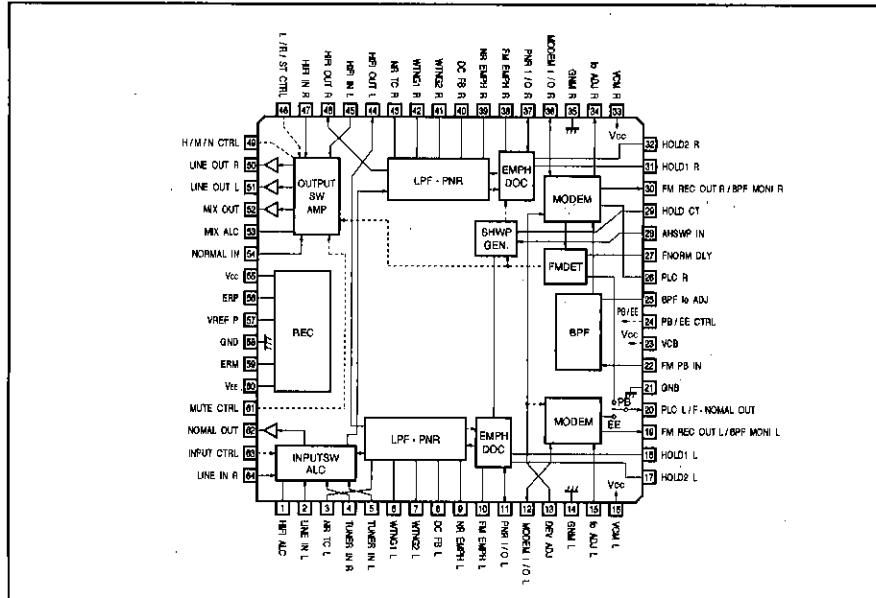
Video cassette recorders

●Features

- 1) Operates off dual \pm power supply which allows a large reduction in the number of coupling capacitors required. A built-in regulator makes it easy to construct a power supply system.
- 2) Two input switch systems are provided (tuner and line). LEFT/RIGHT/STEREO and HiFi/MIX/NORMAL switches are built-in.
- 3) HiFi input has built-in ALC circuit.
- 4) The PNR processor and FM modulation/demodulation circuit provide reverse characteristics at recording and playback to allow combined adjustment of FM deviation

- and playback level.
- 5) Peak-level compression circuit suppresses abnormal noise generation due to pulsating noise sources.
- 6) Switching noise is reduced by a slope-control type differential compensation circuit.
- 7) Built-in FM band-pass filter connects directly to the playback amplifier and excels at attenuation of the other channel. The FM recording output circuit has a high-performance high-frequency cutoff filter that produces a sine wave output.
- 8) Built-in noise-detecting automatic FM detector circuit.

●Block diagram



● Pin descriptions

Pin No.	Pin name	Function	Pin Voltage	I/O circuit
1	HiFi ALC	HiFi audio ALC time constant setting.	0.0V	EF (NPN) ~200Ω
2, 64	LINE IN L, R	Line input (L and R). GND bias resistor required.	0.0V	B (NPN)
3, 43	NR TC L, R	PNR attack and recovery time setting. Attack R: 530Ω, recovery R: 6.5kΩ.	-5.0V	—
4, 5	TUNER IN L, R	Tuner input (L and R). GND bias resistor required.	0.0V	B (NPN)
6, 42	WTNG1 L, R	Waiting characteristic setting.	0.0V	10kΩ
7, 41	WTNG2 L, R	Waiting high-frequency time constant setting (external C = 0.022 μF)	0.0V	1.1kΩ
8, 40	DC FB L, R	PNR operating reference potential.	0.0V	11.5kΩ
9, 39	NR EMPH L, R	NR emphasis time constant setting. R = 18kΩ, 5.6k (external C = 0.01 μF)	0.0V	—
10, 38	FM EMPH L, R	FM emphasis time constant setting. R = 11kΩ, 6.2kΩ (external C = 3300pF)	0.0V	—
11, 37	PNR I/O L, R	PNR processor input/output (EE: compressed output, PB: expanded input)	0.0V	EE: EF (NPN) PB: 50kΩ
12, 36	MODEM I/O L, R	MODEM input/output (EE: modulated input, PB: demodulated output)	2.5V	EE: 50kΩ PB: EF (NPN)
13	DEV ADJ.	Deviation line adjustment.	—	B (NPN)
14, 35	GND _M (GNM) L, R	GND for PNR and MODEM. Both L and R unconnected.	0.0V	—
15, 34	I _o ADJ L, R	VCO control current input.	2.5V	EF (NPN)
16, 33	V _{CCM} (VCM) L, R	V _{CC} for MODEM.	5.0V	—
17, 32	HOLD2 L, R	For connection of slope control differential holding capacitor.	0.0V	EF (NPN) ~1kΩ
18, 31	HOLD1 L, R	For connection of previous value holding capacitor.	0.0V	200Ω
19, 30	FM REC OUT L, R (BPF MONITOR L, R)	Recording FM input pin. Sine wave output. BPF output monitor pin.	EE: 2.7V PB: 2.7V	EF (NPN) ~200Ω
20	PLC L (F - NORMAL OUT)	PLC time constant setting. FM detector signal output.	EE: 0.0V PB: 4.5V 0.0V	EE: EF (NPN) ~50kΩ PB: EF (NPN)
21	GND _a (GNB)	FM BPF GND.	0.0V	—
22	FM PB IN	Playback FM input (660mV _{P-P} Typ). No input coupling capacitor (GND to V _{CC}).	0.0V	33kΩ
23	V _{CCa} (VCB)	FM BPF GND.	5.0V	—
24	PB / EE CTRL	EE mode/PB mode control.	—	B (PNP)
25	BPF I _o ADJ.	FM BPF center frequency adjustment.	1.8V	EF (NPN) ~200Ω
26	PLC R (CARRIER FILTER)	PLC time constant setting. Attack R: 10kΩ. For connection of capacitor for FM detector carrier filter.	EE: 0.0V PB: 2.4V	EE: EF (NPN) ~10kΩ PB: EF (NPN) ~400Ω
27	FNORM DLY	Forced normal signal return delay time setting. Set the time constant with C and R.	—	OPEN - C (NPN)
28	AHSWP IN	Audio head switching pulse input.	—	B (NPN)
29	HOLD CT	Hold time setting.	—	OPEN - C (NPN)
44, 46	HiFi OUT L, R	PNR audio output.	0.0V	EF: (P - P)
45, 47	HiFi IN L, R	HiFi input for output switch.	0.0V	47kΩ
48	L / R / ST CTRL	LEFT/RIGHT/STEREO switch control.	—	B (PNP)
49	H / M / N CTRL	HiFi/MIX/NORMAL switch control.	—	B (PNP)
50, 51	LINE OUT L, R	Line output.	0.0V	330Ω
52	MIX OUT	Mixer amplifier output for RF converter.	0.0V	EF (NPN)

* EF: emitter follower, P-P: push pull, B: base, and C: collector.

All numerical values are standardized values.

● Pin descriptions

Pin No.	Pin name	Function	Pin Voltage	I/O circuit
53	MIX ALC	ALC time constant setting for mixer amplifier. Attack and recovery time setting.	-5.0V	EF (NPN) ~500Ω
54	NORMAL IN	Switch input for normal output	0.0V	B (NPN)
55	V _{CC}	V _{CC} regulator.	5.0V	—
56	ERP	V _{CC} regulator error output.	5.0V	C (NPN)
57	VREF P	V _{CC} /2 reference voltage. With power on detect and precharge function.	2.5V	10kΩ
58	GND	Input/output switch GND.	0.0V	—
59	ERM	V _{EE} regulator error output.	-5.0V	C (NPN)
60	V _{EE}	V _{EE} regulator	-5.0V	—
61	MUTE CTRL	Line output mute control input.	—	3kΩ (2.5V or more)
62	NORMAL OUT	Switch output for normal input	0.0V	B (NPN)
63	INPUT CTRL	TUNER/BIL/LINE input selection control	—	B (PNP)

* I/O circuit; EF: emitter follower, P-P: push pull, B: base, and C: collector.
All numerical values are standardized values.

● Absolute maximum ratings (Ta=25°C)

Parameter	Symbol	Limits	Unit
Applied voltage	V _{IN}	24, 25, 48, 49, 61, 63 pin ··· +6.5	V
	V _{IN}	60pin ············ -6.0	V
	V _{IN}	Other than the pins above ··· +6.0	V
Power dissipation	P _d	800*	mW
Operating temperature	T _{opr}	-10 ~ 70	°C
Storage temperature	T _{stg}	-55 ~ 125	°C

* When IC is stand alone, reduced by 8.0mW for each increase in Ta of 1°C over 25°C. When mounted on 70mm x 70mm², t = 1.6mm glass epoxy PCB, P_d = 1.1W (reduced by 11mW for each increase in Ta of 1°C over 25°C).

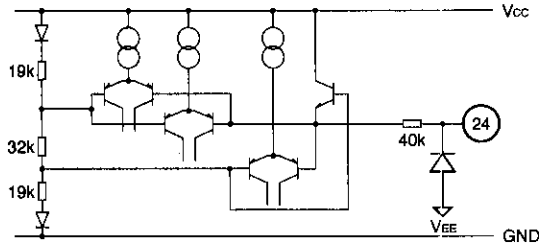
● Recommended operating conditions (Ta=25°C)

Parameter	Symbol	Limits	Unit
Power supply voltage	UNREG - V _{CC}	7.0 ~ *	V
Power supply voltage	UNREG - V _{EE}	7.0 ~ *	V

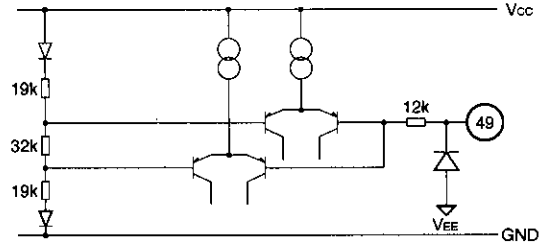
* The built-in regulator in this IC outputs +5.0V from pin 55, and -5.0V from pin 60. The supply voltage range given above is the voltage to be applied to UNREG V_{CC} and UNREG V_{EE} pins in the test circuit to obtain regulator output. Therefore, the upper limit of the voltage range is set by the externally connected transistor that forms the regulator circuit, and not by the IC itself. Note, also, that the lower limit will change depending on the value of the resistor connected between the collector and base of the transistor.

● Input/output circuits

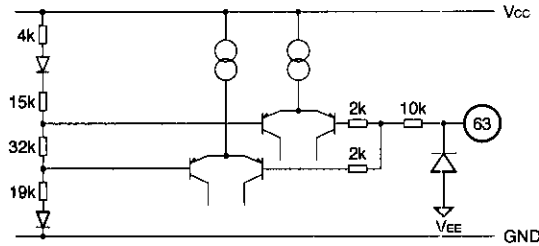
PB / EE CTRL



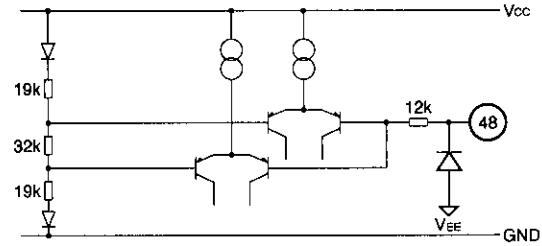
HiFi / MIX / NOMAL CTRL



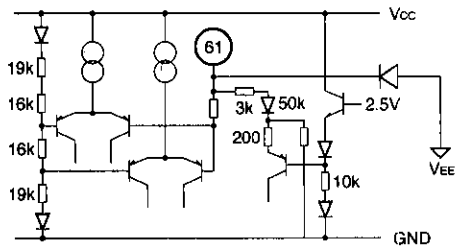
INPUT CTRL



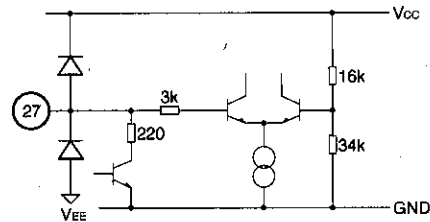
LEFT / RIGHT / STEREO CTRL



MUTE CTRL



FNORM DLY



● Electrical characteristics

• Unless otherwise specified, the following measurement conditions apply:

UNREG - $V_{CC}=+10V$

UNREG - $V_{EE}=-10V$

$T_a=25^{\circ}C$

Input control	(INPUT CTRL pin 63)	: all mode
HiFi/MIX/NORMAL control	(H/M/N CTRL pin 49)	: High (HiFi)
LEFT/RIGHT/STEREO control	(L/R/ST CTRL pin 48)	: Low (STEREO)
MUTE control	(MUTE CTRL pin 61)	: Low (MUTE)
Forced NORMAL control	(FNORM CTRL pin 27)	: Pulled to V_{CC} via R (330kΩ)
PB/EE control	(PB/EE CTRL pin 24)	: High (EE)

* With regard to the control system voltages, refer to the mode holding voltage range.

Signal frequency $f=1kHz$

MODEM carrier frequency NTSC L channel 1.30MHz

MODEM carrier frequency NTSC R channel 1.70MHz

●Electrical characteristics

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
(REGULATOR)						
EE Circuit current (+ supply)	$I_{QP REC}$	23.8	31.8	42.4	mA	EE mode, no input
PB Circuit current (+ supply)	$I_{QP PB}$	33.5	44.7	59.6	mA	PB mode, no input, FNORM
EE Circuit current (- supply)	$I_{QM REC}$	9.0	12.0	16.1	mA	EE mode, no input
PB Circuit current (- supply)	$I_{QM PB}$	9.1	12.1	16.2	mA	PB mode, no input, FNORM
Regulator pin voltage (+)	V_{CC}	4.65	5.00	5.35	V	
Regulator pin voltage (-)	V_{EE}	-5.33	-4.98	-4.63	V	
(EE THROUGH) (INPUT : TU L/R IN, LINE L/R IN, OUTPUT : LINE L/R OUT)						
Line output level (Typ.)	V_{OEE}	-9.1	-8.1	-7.1	dBV	$V_{IN} = -20\text{dBV}$
Distortion	THD_{EE}	—	0.015	0.070	%	$V_{IN} = -20\text{dBV}^{*1}$
Maximum output level	V_{OMEE}	9.2	10.7	—	dBV	$THD = 1\%^{*1}$
ALC level	V_{ALC1}	4.6	6.1	7.6	dBV	$V_{IN} = -3\text{dBV}$, single channel input
Output residual noise	V_{ONEE}	—	-95.0	-90.0	dBV	$R_g = 1\text{k}\Omega^{*2}$
Crosstalk	CT_{EE}	—	—	-78.0	dBV	$V_{IN} = -12\text{dBV}^{*2}$
Muting level	MT_{EE}	—	-116.0	-95.0	dBV	$V_{IN} = -12\text{dBV}^{*2}$
(INPUT : TU L/R IN, LINE L/R IN, OUTPUT : NORMAL OUT)						
Normal out output level	V_{ONORM}	-20.5	-20.0	-19.5	dBV	$V_{IN} = -20\text{dBV}$, simultaneous L & R input
(MIX AMP) (INPUT : TU L/R IN, LINE L/R IN, OUTPUT : MIX OUT)						
Output level	V_{OMIX}	-8.9	-7.9	-6.9	dBV	$V_{IN} = -20\text{dBV}$, simultaneous L & R input
MIX ALC level	V_{ALCMIX}	-5.4	-3.9	-2.4	dBV	$V_{IN} = -14\text{dBV}$, simultaneous L & R input
(PNR ENCODE MODE) (INPUT : TU L/R IN, LINE L/R IN, OUTPUT : PNR L/R OUT)						
Encode output level	V_{OENC}	-16.5	-15.5	-14.5	dBV	$V_{IN} = -20\text{dBV}$
Compression characteristic	CMP	-26.7	-25.0	-23.3	dB	$V_{IN} = -20\text{dBV}$ to -70dBV , output level differential
Encode distortion	THD_{ENC}	—	0.15	0.35	%	$V_{IN} = -20\text{dBV}^{*1}$
Output residual noise	V_{ONENC}	—	-59.0	-54.0	dBV	$R_g = 1\text{k}\Omega^{*2}$
(PNR DECODE MODE) (INPUT : PNR L/R IN, OUTPUT : LINE L/R OUT)						
Output voltage level	V_{ODEC}	-9.1	-7.6	-6.1	dBV	$V_{IN} = -15.5\text{dBV}$
Expansion characteristic	EXP	-52.7	-50.5	-48.3	dB	$V_{IN} = -15.5\text{dBV}$ to -40.5dBV , output level differential
Decode distortion	THD_{DEC}	—	0.05	0.20	%	$V_{IN} = -15.5\text{dBV}^{*1}$

*1 B.W. = 0.4~30 kHz

*2 DIN AUDIO

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions	
(MODEM REC MODE) (INPUT : TU L/R IN, LINE L/R IN, OUTPUT : FM REC L/R OUT)							
Carrier setting resistance	Lch	R _{OL}	12.6	15.0	17.4	kΩ	No signal
	Rch	R _{OR}	9.6	11.5	13.4	kΩ	
Frequency deviation	Lch	DEV _L	43.2	49.2	55.2	kHz	V _{IN} (TU, LINE IN) = -20dBV
	Rch	DEV _R	43.2	49.2	55.2	kHz	
FM output level	Lch	V _{OFML}	325	370	425	mV _{P-P}	
	Rch	V _{OFMR}	320	365	420	mV _{P-P}	
(MODEM PB MODE) (INPUT : FM PB IN, OUTPUT : LINE L/R OUT) Carrier setting resistance, after BPF f0 frequency adjustment, V _{IN} = 660mV _{P-P} , 1.30MHz, 1.70MHz MIX IN							
Demodulated output level	Lch	V _{ODL}	-9.6	-7.6	-5.6	dBV	DEV = ±50kHz
	Rch	V _{ODR}	-9.6	-7.6	-5.6	dBV	
Demodulated distortion 1	Lch	THD _{DL}	—	0.10	0.35	%	DEV = ±50kHz *1
	Rch	THD _{DR}	—	0.10	0.35	%	
Demodulated noise level	Lch	V _{ONDL}	—	-97.5	-87.0	dBV	Unmodulated *2
	Rch	V _{ONDR}	—	-97.5	-87.0	dBV	
(Recording → playback total characteristics) (REC···INPUT : TU L/R IN, LINE L/R IN, OUTPUT : LINE L/R OUT) (PB···INPUT : FM PB IN, OUTPUT LINE L/R OUT)							
Line output recording/ playback level difference	Lch	V _{RPL}	-1.2	0.0	1.2	dB	EE mode: V _{IN} = -20dBV, R _O adjusted for EE mode. PB mode: Input FM PB IN = 660mV _{P-P} EE/PB line out level difference for L, R MIX IN, frequency deviation as for EE (DEV _{L,R}), V _{IN} = -20dBV.
	Rch	V _{RPR}	-1.2	0.0	1.2	dB	
(FM BPF) (INPUT : FM PB IN, OUTPUT : BPF MONITOR L/R)							
BPF center frequency setting resistance value	R _{OBPF}	19.6	25.2	30.8	kΩ	f = 1.505MHz, V _{IN} = 200mV _{P-P} R and L output level the same.	
Lch, Rch mix input signal level, 660mV _{P-P} (ratio 1:1)							
NTSC Lch							
1.30MHz insertion loss	ATT _{NLC}	-14.1	-11.1	-8.1	dB	1.30MHz+1.70MHz FM ALC ON	
1.70MHz insertion loss	ATT _{NL} 1.70	—	—	ATT _{NLC} -30.0	dB	1.30MHz+1.70MHz	
NTSC Rch							
1.70MHz insertion loss	ATT _{NRC}	-15.3	-12.3	-9.3	dB	1.30MHz+1.70MHz FM ALC ON	
1.30MHz insertion loss	ATT _{NR} 1.30	—	—	ATT _{NRC} -30.0	dB	1.30MHz+1.70MHz	
*1 B.W. = 0.4~30 kHz							
*2 DIN AUDIO							

●Electrical characteristics

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions
《DO detector circuit》						
DO detector level	V _{DDO}	76.5	82.5	88.5	dB μ	Input level to give DO due to attenuation.
《Hold pulse generation circuit》						
Hold delay time	$\tau_{D\text{HOLD}}$	—	0.60 0.75	1.30	μS	Time from A.H. PULSE edge to HOLD start.
Hold time	$\Delta\tau_{\text{HOLD}}$	5.55	6.85	8.15	μS	
《Control system mode holding voltages》						
PB / EE CTRL						
EE holding voltage	V _{H24H}	3.90	—	V _{CC}	V	PB / EE CTRL : H
BPF MONISTOP holding voltage	V _{H24M}	2.25	—	2.85	V	PB / EE CTRL : M, H
PB holding voltage	V _{H24L}	0	—	0.90	V	PB / EE CTRL : L
INPUT CTRL						
TU holding voltage	V _{H63L}	0	—	0.90	V	INPUT CTRL2 : L
TU (BIL) holding voltage	V _{H63M}	2.25	—	2.85	V	
LINE holding voltage	V _{H63H}	3.90	—	V _{CC}	V	INPUT CTRL1 : L
H / M / N CTRL						
HiFi holding voltage	V _{H49H}	3.90	—	V _{CC}	V	
MIX holding voltage	V _{H49M}	2.25	—	2.85	V	
NORMAL holding voltage	V _{H49L}	0	—	0.90	V	
L / R / ST CTRL						
STEREO holding voltage	V _{H48L}	0	—	0.90	V	
Rch holding voltage	V _{H48M}	2.25	—	2.85	V	
Lch holding voltage	V _{H48H}	3.90	—	V _{CC}	V	
MUTE CTRL						
MUTE	V _{H7L}	0	—	1.00	V	
DC MUTE	V _{H7H}	3.90	—	V _{CC}	V	
FNORM CTRL						
FNORM holding voltage	V _{H43}	0	—	2.00	V	

● Measurement circuit

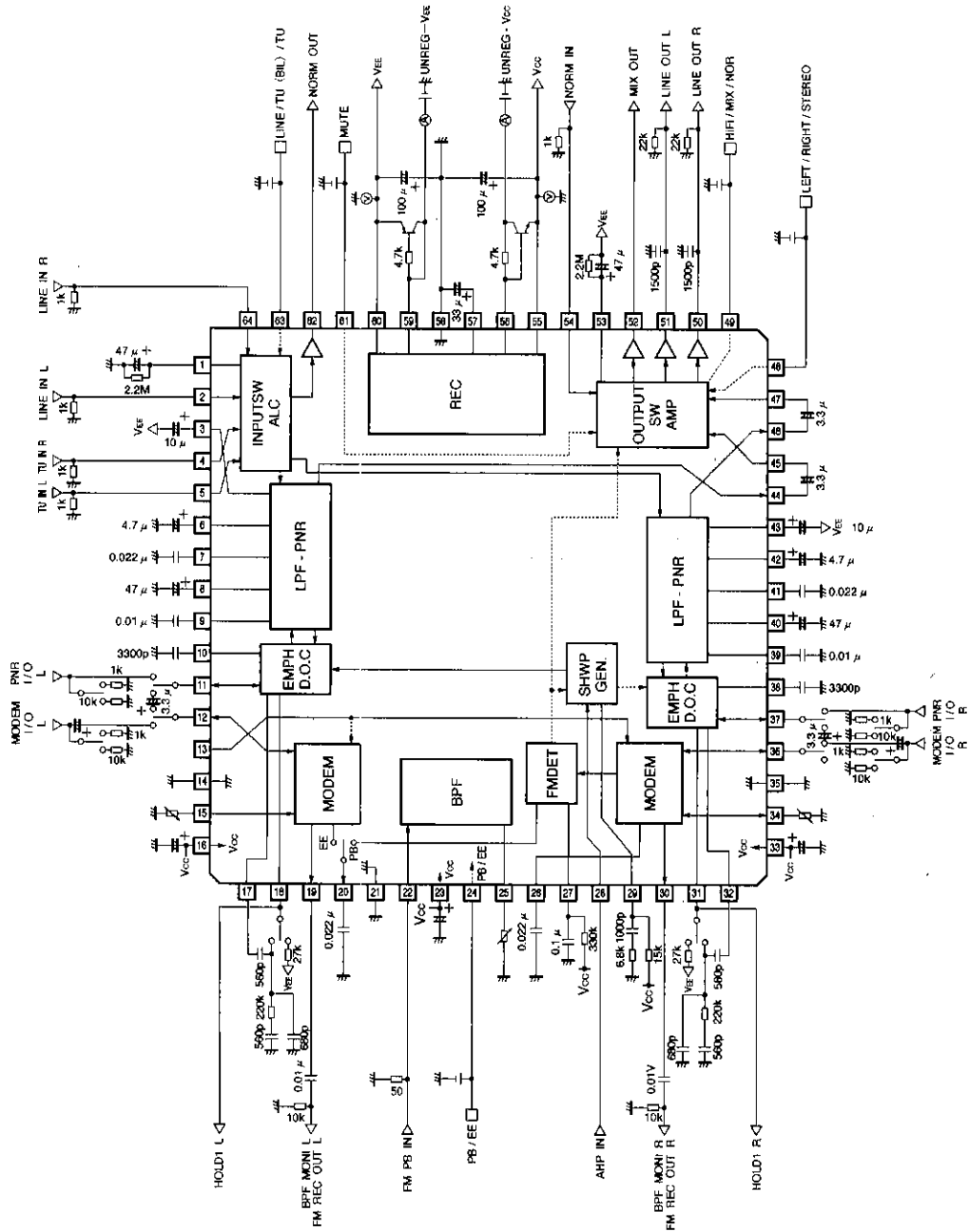


Fig.1

1-1 Function table

The BH7777AK IC incorporates the following functions.

No.	Block name	Main function	Pin number	Power supply
1	Regulator	<ul style="list-style-type: none"> ±5V regulator (V_{CC} and V_{EE}) Anti-pop circuit 	55~60	UNREG-V _{CC} : +10V UNREG-V _{EE} : -10V GND : 58P
2	Input switcher	<ul style="list-style-type: none"> TUNER/LINE switching circuit TUNER/BILINGUAL/LINE switching circuit Normal out terminal ALC amplifier 	1, 2, 4, 5, 62~64	+V _{CC} (internally connected) -V _{EE} (internally connected) GND : 58P
3	Output switcher	<ul style="list-style-type: none"> Line out: 12dB (LINE AMP) LEFT/RIGHT/STEREO switching circuit HiFi/MIX/NORMAL switching circuit Normal in Mute switch RF mixer amplifier with ALC (MIX AMP) 	44~54, 61	+V _{CC} (internally connected) -V _{EE} (internally connected) GND : 58P
4	PNR processor	<ul style="list-style-type: none"> 20kHz line low-pass filter (20kHz LPF) PNR processor (MOA, CCA, WTNG, DET) Fixed emphasis/de-emphasis (EMPH/DEEMPH) Switching noise slope control-type differential compensation circuit 	3, 6~12, 36~43	+V _{CC} (internally connected) -V _{EE} (internally connected) GND : 58P
5	Modulation/demodulation	<ul style="list-style-type: none"> FM modulator/demodulator circuit Recording FM high-frequency cutoff filter (FM LPF) Over-modulation limiter (AUDIO LIM) PLC circuit (PLC) Playback FM limiter (FM LIM) 	13~19, 30~35	V _{CC} : 16, 33P GND : 14, 35P
6	FM detector control	<ul style="list-style-type: none"> D.O. detect circuit (D.O. DET) Noise-detect method automatic FM detector circuit (FM DET) Hold pulse generator 	20, 26~29	V _{CC} : 16, 33P GND : 14, 35P
7	FM BPF	<ul style="list-style-type: none"> Lch and Rch FM band-pass filter Input level adjustment circuit (FM ALC) 	19, 30, 21~23, 25	V _{CC} : 23P GND : 21P

Single-chip Hi-Fi audio signal processors

VCR components

1-2 HiFi and normal audio system flowchart

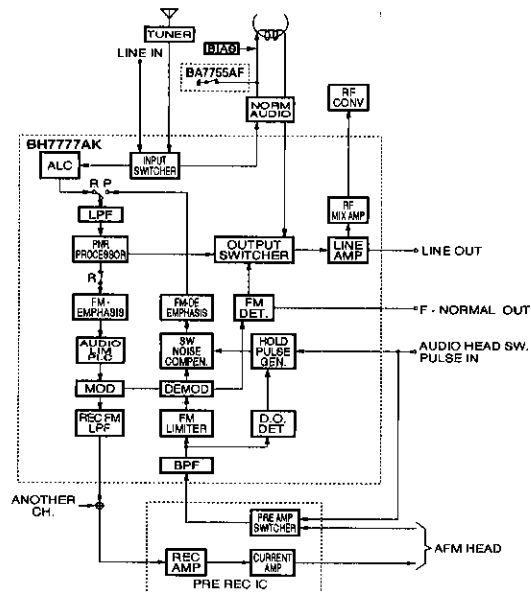


Fig.2

2. Signal flow and level diagram

2-1 HiFi audio signal flow for recording (EE through)

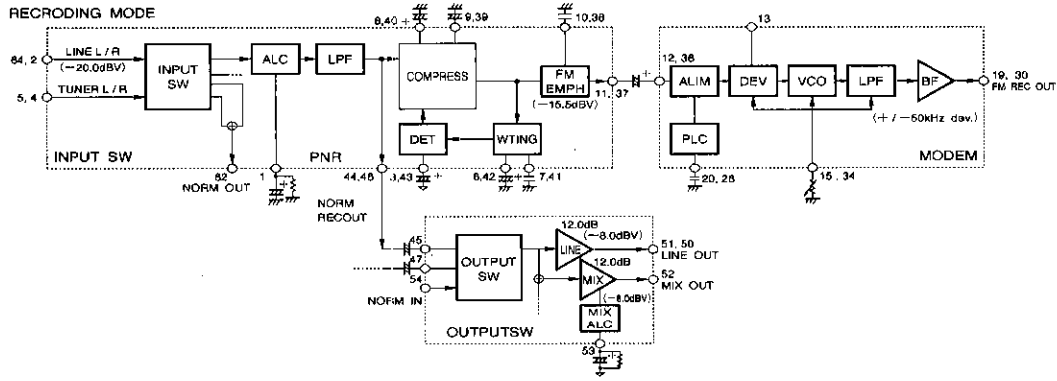


Fig.3

2-2 HiFi audio signal flow for playback

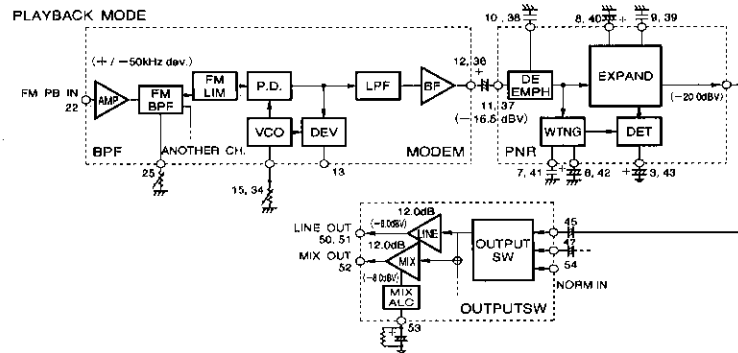


Fig.4

2-3 HiFi audio level diagram

Signal levels for the signals passing through the blocks are shown below (for recording and playback).
 • f=1kHz and standard level.

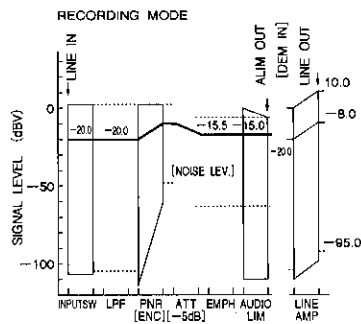


Fig.5

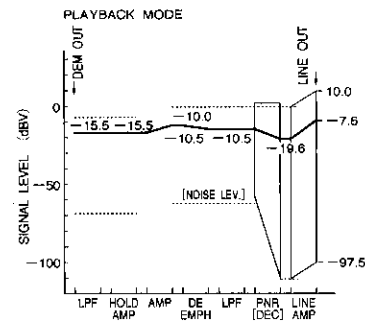


Fig.6

●Control terminals

3-1 Control terminals

The IC has the following six control terminals.

1)Recording/playback control (PB/EE CTRL: pin 24) EE, PBF and MONITOR OFF modes can be set.

Mode	Control signal	Notes
PB	L	PB mode
BPF MONI OFF	M	PB mode, BPF MONITOR output off
EE	H	EE mode

2)Forced normal control (FNORM DLY: pin 27)

During playback, regardless of the line output mode setting, it is possible to force the output switch to the normal output mode setting (except when mute is "H").

Mode	Control signal	Notes
FNORM	H (OPEN)	Follows the detect state of the auto FM detect circuit.
FNORM	L	Forced normal.

Note: This is also used for the time constant setting function for the automatic FM signal detector circuit (FNORM DLY), when a time constant circuit is connected, leave FNORM mode open.

3)Output switch HiFi/MIX/NORMAL control (H/M/N CTRL: pin 49)

Output switcher HiFi/MIX/NORMAL switching.

Mode	Control signal	Notes
NORMAL	L	NORMAL mode
MIX	M	HiFi + NORMAL mode
HiFi	H	HiFi mode

4)Output switch LEFT/RIGHT/STEREO control (L/R/ST CTRL: pin 48)

Output switcher LEFT/RIGHT/STEREO switching.

Mode	Control signal	Notes
STEREO	L	LINE OUT L: Lch output, LINE OUT R: Rch output
RIGHT	M	LINE OUT L: Rch output, LINE OUT R: Rch output
LEFT	H	LINE OUT L: Lch output, LINE OUT R: Lch output

5)Mute control (MUTE CTRL: pin 61)

Stops line output and MIX output.

Mode	Control signal	Notes
MUTE	L	
MUTE	H	Line mute and DC mute operates.

Note: Be certain to set mute to H at power on and power off.

6)Input control (INPUT CTRL: pin 63)

Input switcher LINE/BILINGUAL/TUNER switching.

Mode	Control signal	Notes
TUNER	L	HiFi : TUNER L / R, NORMAL OUT : TUNER L+R
TU (BIL)	M	HiFi : TUNER L / R, NORMAL OUT : TUNER L
LINE	H	HiFi : LINE L / R, NORMAL OUT : LINE L+R

●Electrical characteristic curves

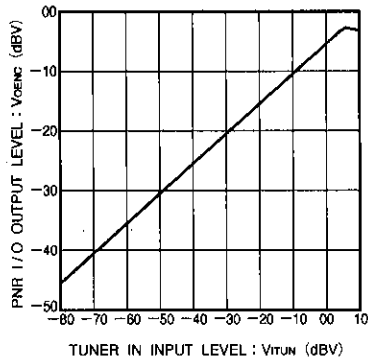


Fig. 8 PNR encode mode input/output characteristics

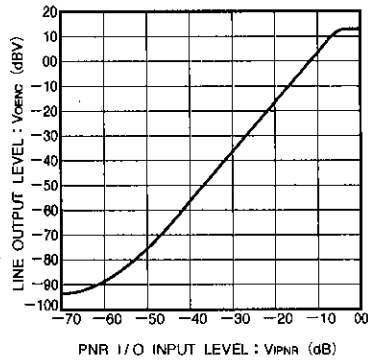


Fig. 9 PNR decode mode input/output characteristics

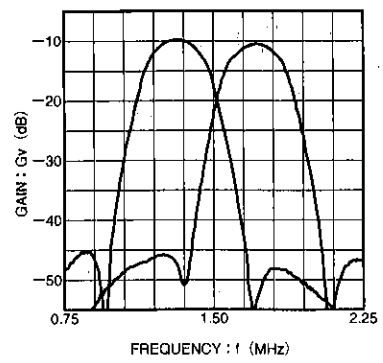
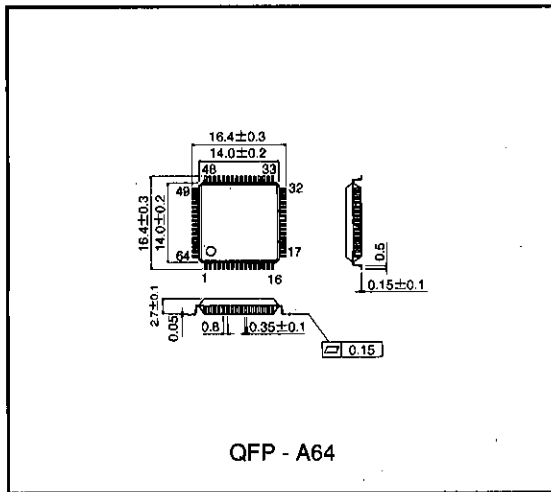


Fig. 10 FM BPF standard characteristic (NTSC)

●External dimensions (Units: mm)



Single-chip Hi-Fi audio signal processors

VCR components

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