Sound Processors for Home Theater Systems

6.1ch Sound Processor

BD3816K1,BD3817KS

No.10081EAT06

●Description

The BD3816K1 and BD3817KS are 6.1ch sound processors. Functions required for applications, such as AV receivers and home theater systems, are integrated into a single chip. A wide dynamic range of 132dB is achieved by utilizing the BiCMOS process.

●Features

1) Dynamic range: 132dB (Volume Direct Mode, VOL=MUTE, IHF-A)
2) Independent 7 channels for Master Volume (0 to -95 dB, MUTE 1dB/Step)
3) Supporting 2nd room entertainment/2nd source recording.
4) Low current consumption design achieved by adopting the Bi-CMOS process.
5) Maximum output voltage: 4.2Vrms (VCC=7V, VEE=-7V, RL=10kΩ).
6) Built-in Input Gain Amp useful for amplifying input signals (0-7dB, 1dB/Step).
7) Built-in Output Gain Amp useful for adjusting output signal voltages (0-17dB, 1dB/Step)
8) Built-in mixing circuit for distributing the output signals from Center and Subwoofer channel to Front R/L channels (0, -3, -4.5dB).
9) 2ch Volume control BD3812F or 6ch Function Switch BD3843FS can be controlled simultaneously by the serial control bus.
10) REC A output terminal with a REC input/output switch useful for monitoring Equalizer Amp. (For BD3816K1, available as an input function of the seventh line.)
11) Output mute controlled by either serial data or an external control terminal.
12) 2-wire serial control (For both 3.3V and 5V)

●Applications

AV receivers, home theater systems, and mini-audio systems.

●Line up matrix

Parameter	BD3816K1	BD3817KS
Number of Input Selectors	6(+1) inputs (ROUTA terminal: available as an input selector of the seventh line)	10 inputs, 2 outputs
Input Gain	0 ~ 7dB 1dB/step	0 ~ 7dB 1dB/step
Volume	0 ~ -95dB 1dB/step、7ch	0 ~ -95dB 1dB/step、7ch
Bass, Treble	±14dB 2dB/step	±14dB 2dB/step
Output Gain	0 ~ 17dB 1dB/step	0 ~ 17dB 1dB/step
Mixing	Yes	Yes
Package	QFP80	SQFP100

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●Absolute maximum ratings (Ta=25℃)

Parameter	Symbol	Ratings	Unit
Power Supply Voltage	V_{CC}	7.5 *1	V
	V_{EE}	-7.5	
Power Dissipation	Pd	1200 (BD3816K1) *2 1300 (BD3817KS)	mW
Operating Temperature Range	Topr	-20 ~ +75	℃
Storage Temperature Range	Tstg	-55 ~ +125	℃

*1 Even in the specified range of Power Supply Voltage, applying voltage only to the VCC side may cause an excessive current to give a permanent damage to the IC.
When starting up power supplies, VEE and VCC should be powered on simultaneously or VEE first; then followed by VCC.

*2 Reduced by 12 mW/℃ over 25℃ (BD3816K1), when installed on the standard board (size: 70x70x1.6mm).
Reduced by 13 mW/℃ over 25℃ (BD3817KS), when installed on the standard board (size: 70x70x1.6mm)

●Operating conditions

Must function normally at Ta=25°C.

Parameter	Symbol	Ratings			Unit
		Min.	Typ.	Max.	
Operating source voltage	V_{CC}	5.0	7.0	7.3	V
	V_{EE}	-7.3	-7.0	-5.0	

●Electrical characteristics

Ta=25℃, V_{CC}=7V, f=1kHz, Vin=1Vrms, RL=10kΩ, Rg=600Ω, Input Gain=0dB, Volume=0dB, Output Gain=0dB, Bass=0dB, Treble=0dB, Mixing c/sw=OFF, unless otherwise noted.

Parameter		Symbol	Limits			Unit	Conditions
			Min.	Typ.	Max.		
Circuit Current	VCC	IQ	—	24	40	mA	No signal
	VEE		-40	-24	—		
Output Voltage Gain		Gv	-2	0	2	dB	
Total Harmonic Distortion Ratio		THD	—	0.001	0.03	%	BW=400Hz-30kHz
Maximum Output Voltage		Vomax	3.6	4.2	—	Vrms	THD=1%
Output Noise Voltage		Vno	—	2.0	12	μVrms	Rg=0Ω, BW=IHF-A (Output gain ON, Tone ON)
			—	1.5	8	μVrms	Rg=0Ω, BW=IHF-A (Output gain ON, Tone OFF)
			—	1.2	8	μVrms	Rg=0Ω, BW=IHF-A (*OM=Volume Direct)
Cross-talk between Channels		CTC	—	-95	-80	dB	Rg=0Ω, BW=IHF-A
Cross-talk between Selectors		CTS	—	-95	-80	dB	Rg=0Ω, BW=IHF-A
Volume Output Voltage		GVV	-2	0	2	dB	
Volume Total Harmonic Distortion Ratio		THDV	—	0.001	0.03	%	BW=400Hz-30kHz
Volume Output Noise Voltage		VnoV	—	1.2	8	μVrms	Rg=0Ω, BW=IHF-A

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Parameter	Symbol	Limits			Unit	Conditions
		Min.	Typ.	Max.		
Volume Control Range	VOL	-97.5	-95	-92.5	dB	Vin=3Vrms *OM=Volume Direct
Volume Setting Error 1	VOLE1	-1.5	0	1.5	dB	0 to -53dB, Vin=3Vrms *OM=Volume Direct
Volume Setting Error 2	VOLE2	-2.5	0	2.5	dB	-54dB to -95dB, Vin=3Vrms *OM=Volume Direct
Maximum Attenuation	VOLmin	—	-115	-105	dB	Vin=3Vrms, BW=IHF-A *OM=Volume Direct
Treble Maximum Boost Gain	GTB	12	14	16	dB	f=15kHz, Vin=0.4Vrms
Treble Maximum Cut Gain	GTC	-16	-14	-12	dB	f=15kHz, Vin=0.4Vrms
Treble Step Resolution	TR	—	2	—	dB	f=15kHz, Vin=0.4Vrms
Treble Gain Setting Error	TE	-2	0	2	dB	f=15kHz, Vin=0.4Vrms
Bass Maximum Boost Gain	GBB	12	14	16	dB	f=100Hz, Vin=0.4Vrms
Bass Maximum Cut Gain	GBC	-16	-14	-12	dB	f=100Hz, Vin=0.4Vrms
Bass Step Resolution	BR	—	2	—	dB	f=100Hz, Vin=0.4Vrms
Bass Gain Setting Error	BE	-2	0	2	dB	f=100Hz, Vin=0.4Vrms
C Mixing Gain Control Range	GMCG	-6.5	-4.5	-2.5	dB	*OM=Volume Direct
C Mixing Gain Setting Error	GMCE	-2	0	2	dB	*OM=Volume Direct
SW Mixing Gain Control Range	GMSWG	-6.5	-4.5	-2.5	dB	*OM=Volume Direct
SW Mixing Gain Setting Error	GMSWE	-2	0	2	dB	*OM=Volume Direct
Input Gain Control Range	GIG	5	7	9	dB	Vin=0.4Vrms *OM=Volume Direct
Input Gain Setting Error	GIE	-2	0	2	dB	Vin=0.4Vrms *OM=Volume Direct
Output Gain Control Range	GOG	15	17	19	dB	Vin=0.4Vrms *OM=Output gain ON(Tone OFF)
Output Gain Setting Error	GOE	-2	0	2	dB	Vin=0.4Vrms *OM=Output gain ON(Tone OFF)
ROUT Output Impedance	RoutR	—	20	100	Ω	
ROUT Voltage Gain	GVR	-2	0	2	dB	RL=47kΩ
ROUT Total Harmonic Distortion Ratio	THDR	—	0.005	0.09	%	RL=47kΩ, BW=400Hz-30kHz

* OM:Output mode
* Note: This IC is not designed to be radiation-resistant.

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●Timing chart

1) Signal Timing Conditions

- Data is read on the rising edge of the clock.
- Latch is read out on the falling edge of the clock.
- Latch signal must terminate with the LOW state.
  * To avoid malfunctions, clock and data signals must terminate with the LOW state.

1byte=17bit

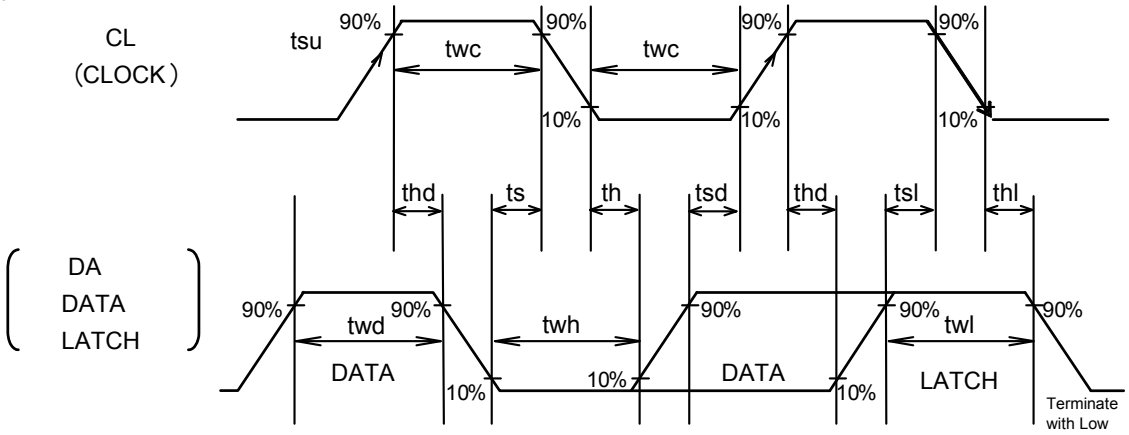


Fig. 1

Parameter	Symbol	Limits			Unit
		Min.	Typ.	Max.	
Minimum Clock Width	twc	1.0	—	—	μs
Minimum Data Width	twd	1.0	—	—	μs
Minimum Latch Width	twl	1.0	—	—	μs
LOW Hold Width	twh	1.0	—	—	μs
Data Set-up Time (DATA→CLK)	tsd	0.5	—	—	μs
Data Hold Time (CLK→DATA)	thd	0.5	—	—	μs
Latch Set-up Time (CLK→LATCH)	tsl	0.5	—	—	μs
Latch Hold Time (DATA→LATCH)	thl	0.5	—	—	μs
Latch Low Set-up Time	ts	0.5	—	—	μs
Latch Low Hold Time	th	0.5	—	—	μs

2) Voltage Conditions for Control Signals

Parameter	Condition	Limits			Unit
		Min.	Typ.	Max. (≦Vcc)	
"H" Input Voltage	Vcc=5 ~ 7.3V VEE=-5 ~ -7.3V	2.2	—	5.5	V
"L" Input Voltage		0	—	1.0	V

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3) Control Data Format List

←Data input Direction

	MSB																LSB
	D16	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
Data	Data														Select Address		

(1)BD3816K1 Control Data Formats

	D16	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	Select Address D2	D1	D0
Data ①	FRL select		6.1ch select		Input select				0				0	0	0	0	0
Data ②	REC A mode select		REC B	REC C	Output mode select		0						0	1	0	0	0
Data ③	Treble				Bass				Mixing Cch		Mixing SWch		1	0	0	0	0
Data ④	Input gain FRLch			Input gain SRLch			Input gain Cch			Input gain CBch			1	1	0	0	0
Data ⑤	Master volume and Output gain				SWch			Input gain SWch			0				0	0	1
Data ⑥	Master volume and Output gain				FRch		D0	Master volume and Output gain			FLch				0	1	0
Data ⑦	Master volume and Output gain				SRch		D0	Master volume and Output gain			SLch				0	1	1
Data ⑧	Master volume and Output gain				Cch		D10	Master volume and Output gain			CBch				1	0	1

・By changing Select Address, eight different control formats are selectable.
For Select Address, the values, except for those shown above, must not be specified.
・At power-on sequence, initialize all data.

(Example)

← Data input Direction

MSB LSB MSB LSB MSB LSB MSB LSB MSB LSB MSB LSB MSB LSB MSB LSB

Data①	L	Data②	L	Data③	L	Data④	L	Data⑤	L	Data⑥	L	Data⑦	L	Data⑧	L

"L" means latch.

・After power-on, for the second and subsequent times, only the necessary data can be selected for setting.

Example: When changing the input gain in the example:

Data input Direction

←MSB LSB

Data④	L

"L" means latch.

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(2)BD3817K1 Control Data Formats

	D16	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	Select Address D2	D1	D0
Data ①	FRL select		6.1ch select		Input select1				Input select2				0	0	0	0	0
Data ②	REC A mode select		REC B	REC C	Output mode select		0						0	1	0	0	0
Data ③	Treble				Bass				Mixing Cch		Mixing SWch		1	0	0	0	0
Data ④	Input gain FRLch			Input gain SRLch			Input gain Cch			Input gain CBch			1	1	0	0	0
Data ⑤	Master volume and Output gain				SWch			Input gain SWch			0				0	0	1
Data ⑥	Master volume and Output gain				FRch		D0	Master volume and Output gain				FLch			0	1	0
Data ⑦	Master volume and Output gain				SRch		D0	Master volume and Output gain				SLch			0	1	1
Data ⑧	Master volume and Output gain				Cch		D10	Master volume and Output gain				CBch			1	0	1

・By changing Select Address, eight different control formats are selectable.
For Select Address, the values, except for those shown above, must not be specified.
・At power-on sequence, initialize all data.

Example:

← Data input Direction

MSB LSB	MSB LSB	MSB LSB	MSB LSB	MSB LSB	MSB LSB	MSB LSB	MSB LSB
Data① L	Data② L	Data③ L	Data④ L	Data⑤ L	Data⑥ L	Data⑦ L	Data⑧ L

"L" means latch.

・After power-on, for the second and subsequent times, only the necessary data can be selected for setting.

Example: When changing the input gain in the example:

Data input Direction

← MSB LSB

Data④	L

"L" means latch.

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●Block diagram, application circuit

1) BD3816K1

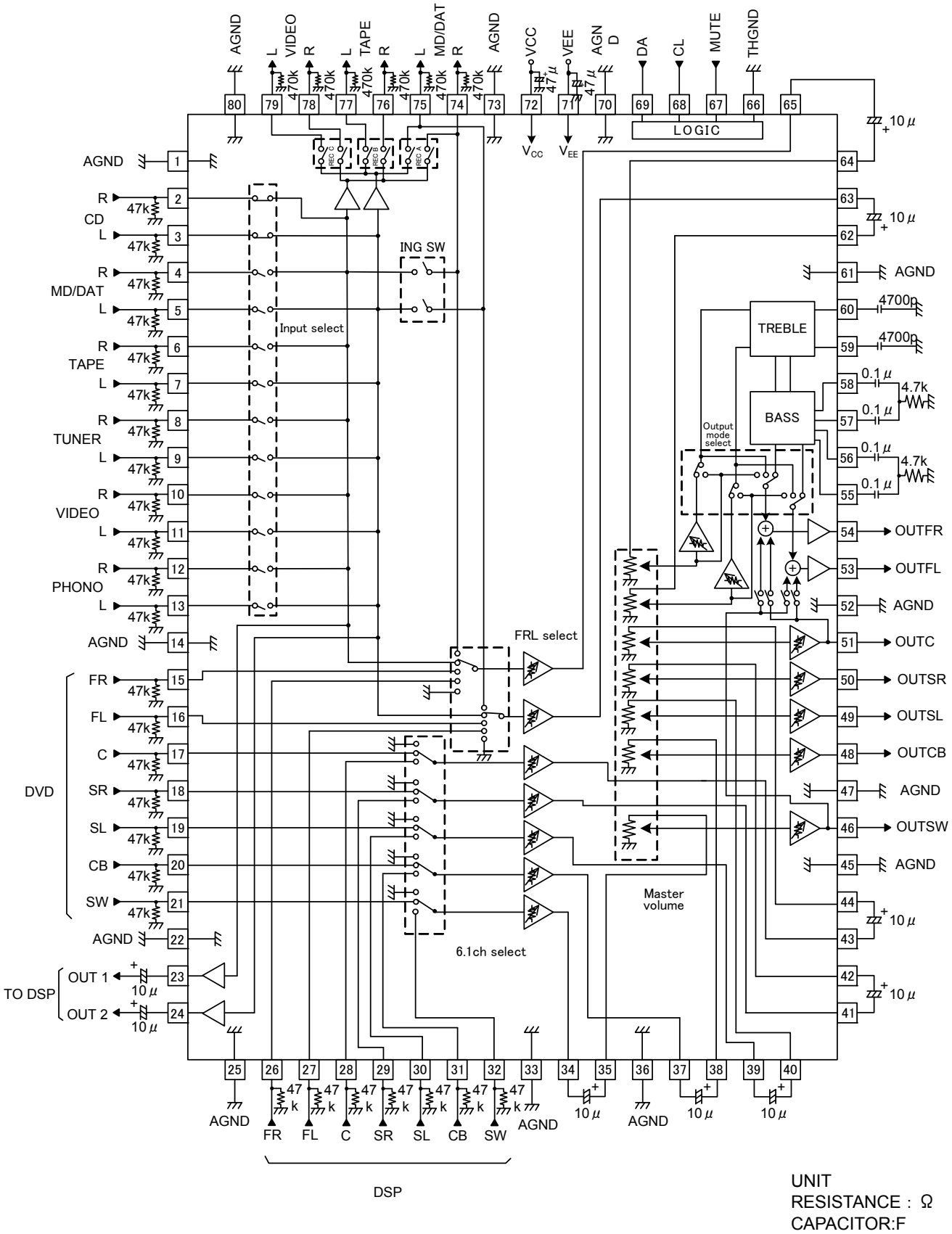


Fig. 2

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2) BD3817KS

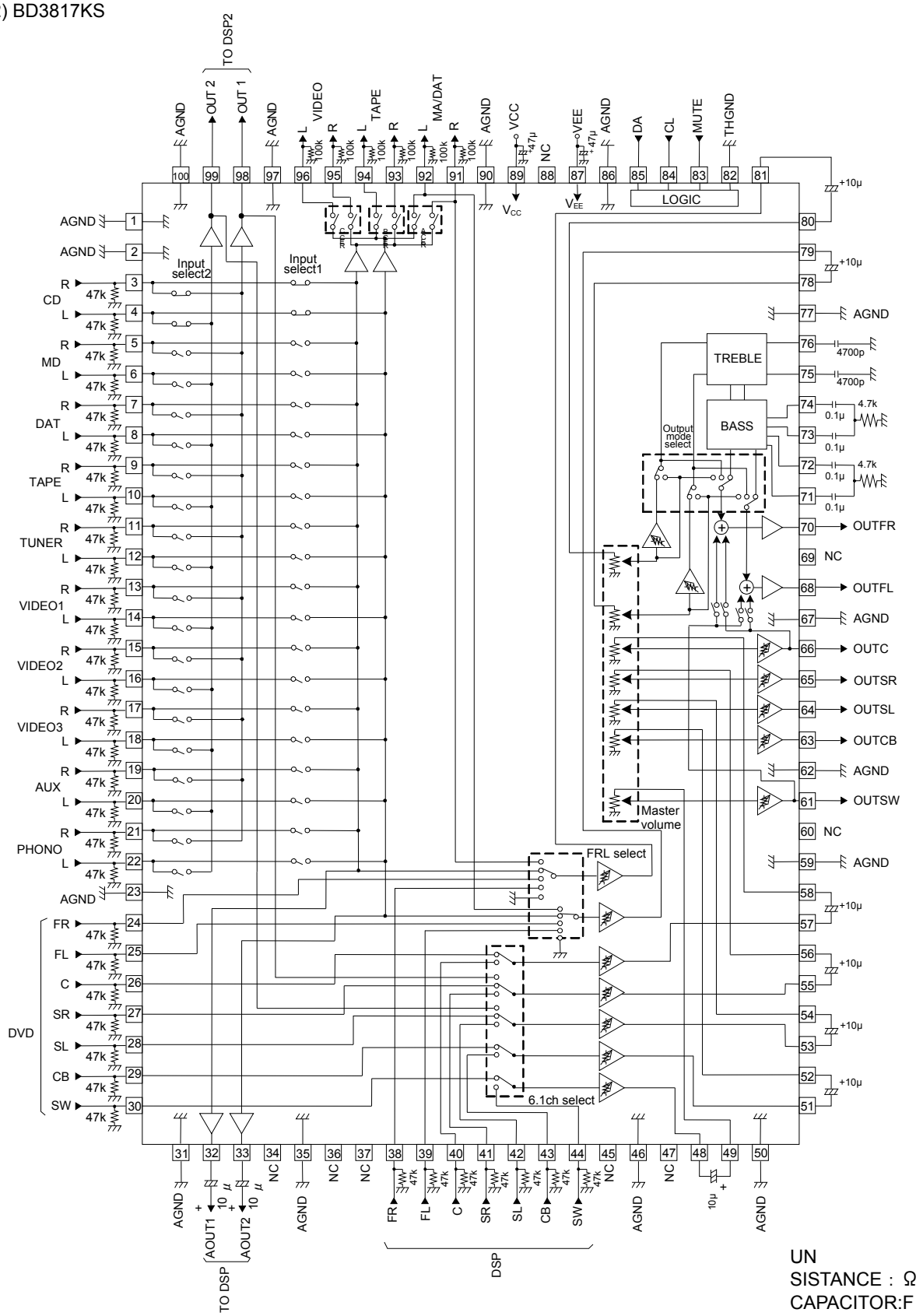
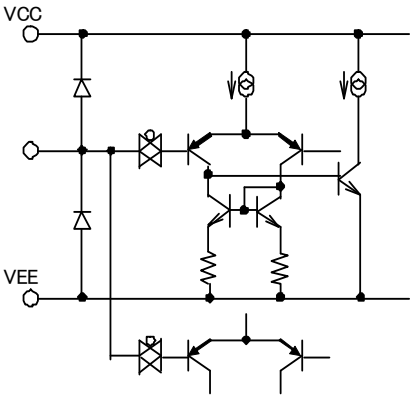
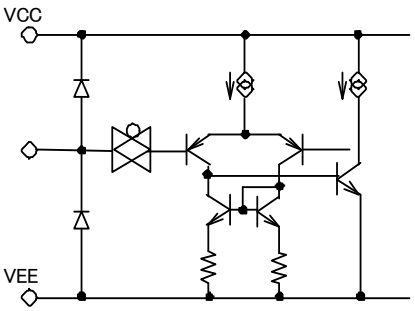


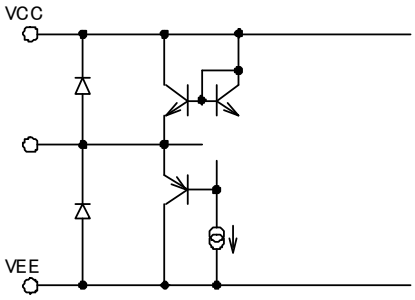
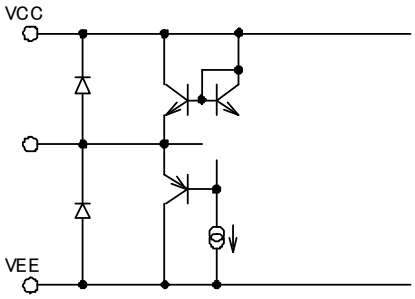
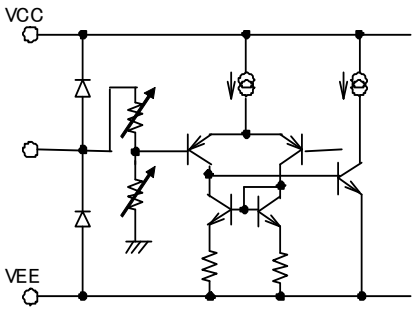
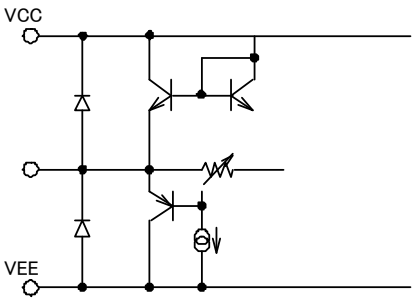
Fig. 3

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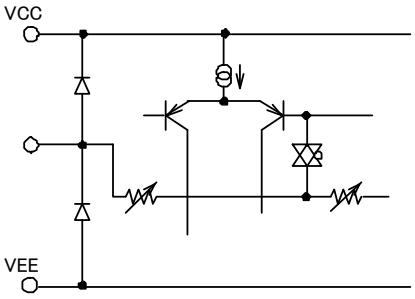
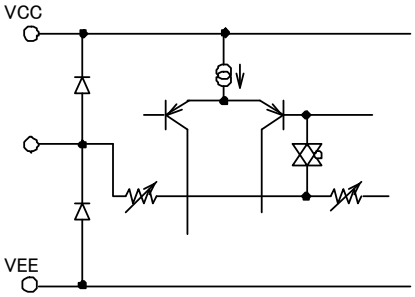
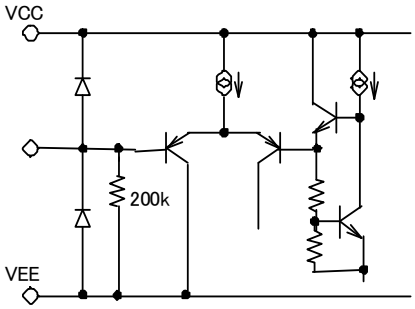
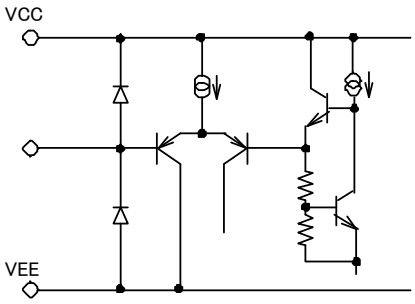
●**Equivalent circuit**

BD3816K1		BD3817KS				
Pin No.	Pin Name	Pin No.	Pin Name	Pin Voltage	Equivalent circuit	Description
1 14 22 25 33 36 45 47 52 61 70 73 80	AGND1 AGND2 AGND3 AGND4 AGND5 AGND6 AGND7 AGND8 AGND9 AGND10 AGND11 AGND12 AGND13	1 2 23 31 35 46 50 59 62 67 77 86 90 97 100	AGND1 AGND2 AGND3 AGND4 AGND5 AGND6 AGND7 AGND8 AGND9 AGND10 AGND11 AGND12 AGND13 AGND14 AGND15	0	—	Ground pins
2 3 4 5 6 7 8 9 10 11 12 13	INA1 INA2 INB1 INB2 INC1 INC2 IND1 IND2 INE1 INE2 INF1 INF2	3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22	INA1 INA2 INB1 INB2 INC1 INC2 IND1 IND2 INE1 INE2 INF1 INF2 ING1 ING2 INH1 INH2 INI1 INI2 INJ1 INJ2	0		Signal input pins; the recommended Input Impedance value is 47kΩ, provided by an external resistance.
15 16 17 18 19 20 21 26 27 28 29 30 31 32	INDVDFR INDVDFL INDVDC INDVDSR INDVDSL INDVDCB INDVDSW INDSPFR INDSPFL INDSPC INDSPSR INDSPSL INDSPCB INDSPSW	24 25 26 27 28 29 30 38 39 40 41 42 43 44	INDVDFR INDVDFL INDVDC INDVDSR INDVDSL INDVDCB INDVDSW INDSPFR INDSPFL INDSPC INDSPSR INDSPSL INDSPCB INDSPSW	0		Signal input pins; the recommended Input Impedance value is 47kΩ, provided by an external resistance.

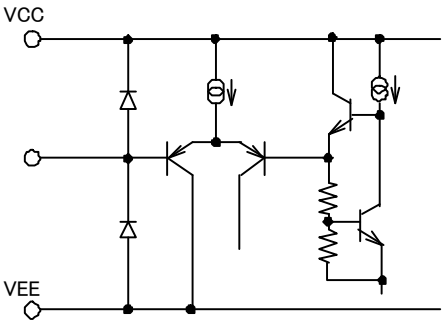
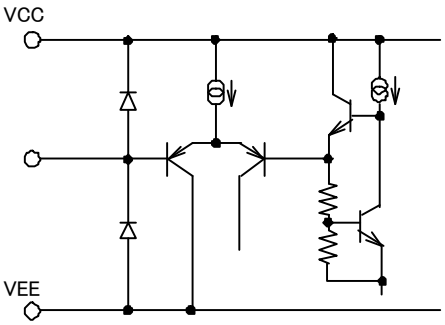
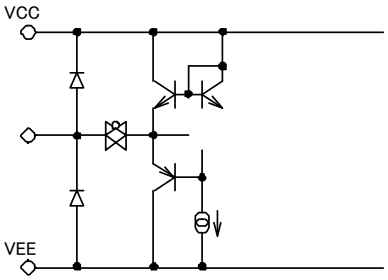
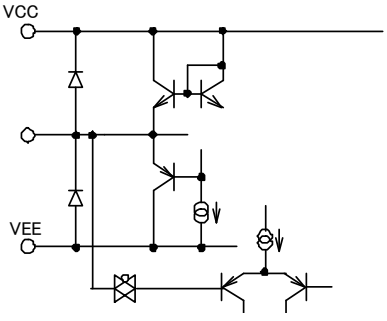
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BD3816K1		BD3817KS				
Pin No.	Pin Name	Pin No.	Pin Name	Pin Voltage	Equivalent circuit	Description
23 24 46 48 49 50 51 53 54	OUT1 OUT2 OUTSW OUTCB OUTSL OUTSR OUTC OUTFL OUTFR	32 33 61 63 64 65 66 68 70	AOUT1 AOUT2 OUTSW OUTCB OUTSL OUTSR OUTC OUTFL OUTFR	0		Signal output pins
34 37 39 41 43 63 65	GOUTSW GOUTCB GOUTSL GOUTSR GOUTC GOUTFL GOUTFR	48 51 53 55 57 79 81	GOUTSW GOUTCB GOUTSL GOUTSR GOUTC GOUTFL GOUTFR	0		Signal output from input gain pins
35 38 40 42 44 62 64	VINSW VINCB VINSL VINSR VINC VINFL VINFR	49 52 54 56 58 78 80	VINSW VINCB VINSL VINSR VINC VINFL VINFR	0		Signal input to master volume pins, Input Impedance: 20kΩ(at Typ.)
55 57	BNFB2 BNFB1	71 73	BNFB2 BNFB1	0		Bass frequency characteristic and gain setting pins

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BD3816K1		BD3817KS				
Pin No.	Pin Name	Pin No.	Pin Name	Pin Voltage	Equivalent circuit	Description
56 58	BNFA2 BNFA1	72 74	BNFA2 BNFA1	0		Bass frequency characteristic and gain setting pins
59 60	TNF2 TNF1	75 76	TNF2 TNF1	0		Treble frequency characteristic and gain setting pins
66	THGND	82	THGND	0	—	Ground pin for Comparator
67	MUTE	83	MUTE	—		External mute pin
68	CL	84	CL	—		Serial clock input pin

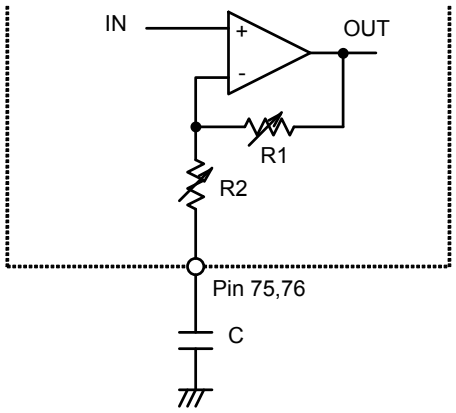
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BD3816K1		BD3817KS				
Pin No.	Pin Name	Pin No.	Pin Name	Pin Voltage	Equivalent circuit	Description
69	DA		DA	—		Serial data input pin
71	VEE		VEE	—		Negative power supply pin
72	VCC		VCC	—		Positive power supply pin
74 75	ROUTA1 ROUTA2		ROUTA1 ROUTA2	0		Input/output for REC pins
76 77 78 79	ROUTB1 ROUTB2 ROUTC1 ROUTC2		ROUTB1 ROUTB2 ROUTC1 ROUTC2	0		Signal output for REC pins
—	—	98 99	OUT1 OUT2	0		Signal output pins

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●Setting constants for tone control filters

1) Treble filter



$$fc = \frac{1}{2\pi R2C} \quad (Hz)$$

$$G = 20\log \frac{R1+R2+Zc}{R2+Zc} \quad (dB)$$

$$Zc = \frac{1}{j\omega C} \quad (\Omega)$$

Standard values of R1, R2 (reference)

Treble Boost Amount Cut Amount	Resistance (KΩ) *Typ.	
	R1	R2
0dB	0	20
±2dB	4.1	15.9
±4dB	7.3	12.7
±6dB	10.3	9.7
±8dB	12.3	7.7
±10dB	14.0	6.0
±12dB	15.4	4.6
±14dB	16.5	3.5

*The actual boost /cut amount may deviate from the standard values in some degree.

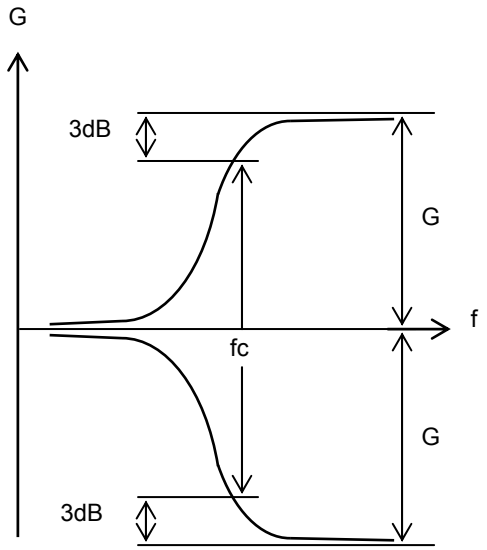


Fig. 5

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2) Bass filter

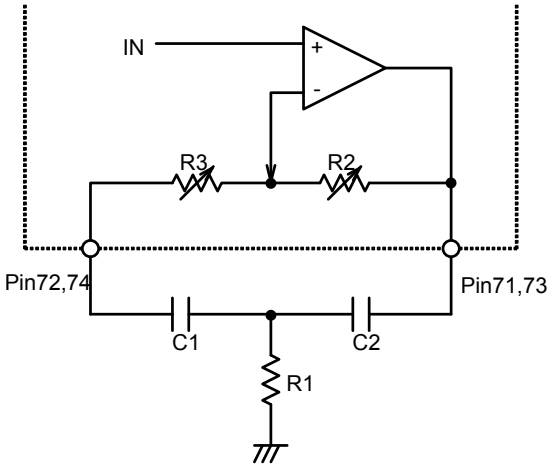


Fig. 6

$$fo = \frac{1}{2\pi\sqrt{R1(R2 + R3)C1C2}} \quad (HZ)$$

$$Q = \frac{1}{C1 + C2}\sqrt{\frac{C1C2R2}{R1}}$$

When C1=C2

$$G \approx 20\log \frac{\frac{R2 + R3}{R1} + 2}{\frac{R3}{R1} + 2} \quad (dB)$$

Standard values of R2, R3 (reference)
(R1=4.7KΩ,C1=C2=0.1μF)

Boost Amount Cut Amount	Resistance (KΩ) *Typ.	
	R2	R3
0dB	0	39.5
±2dB	10.3	29.2
±4dB	18.4	21.1
±6dB	24.8	14.7
±8dB	29.9	9.6
±10dB	33.8	5.7
±12dB	36.9	2.6
±14dB	39.5	0

*The actual boost/cut amounts may deviate from the standard values in some degree.

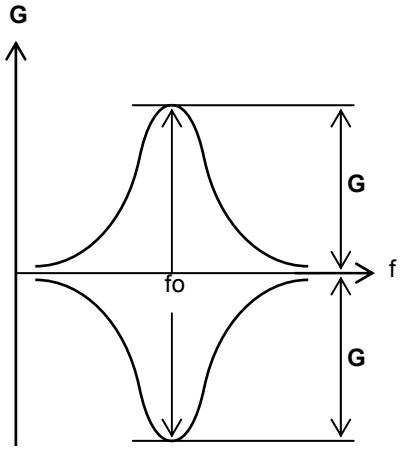


Fig. 7

* Bass Filter Feature

To be able to set the f0 and Q factors of Bass characteristics to desired values, part of the Bass Filter is constructed of the external components, shown in Fig.6

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●Reference data

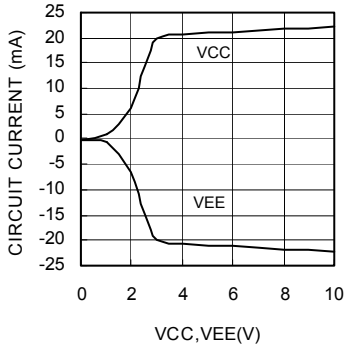


Fig.8 Circuit Current - Voltage Supply

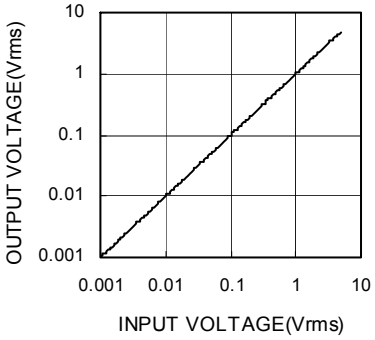


Fig.9 Output Voltage - Input Voltage

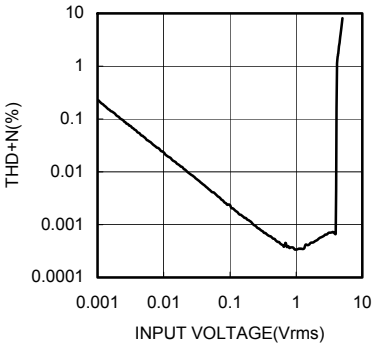


Fig.10 Total Harmonic Distortion - Input Voltage

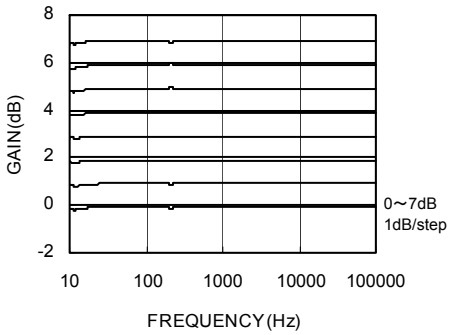


Fig.11 Input Gain - Frequency

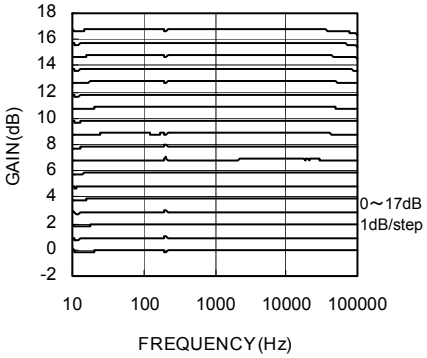


Fig.12 Output Gain - Frequency

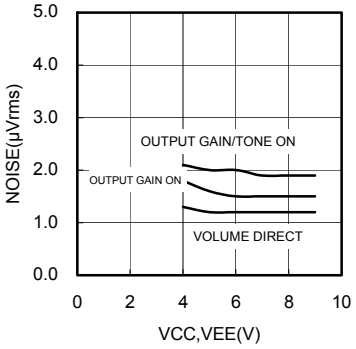


Fig.13 Output Noise Voltage - Power Supply Voltage

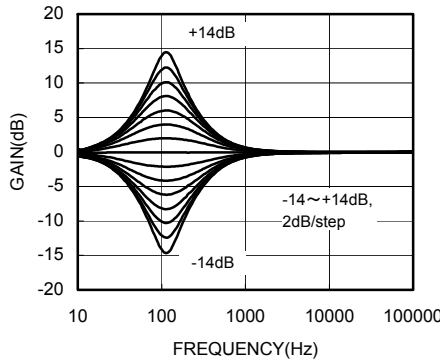


Fig.14 Bass Gain - Frequency

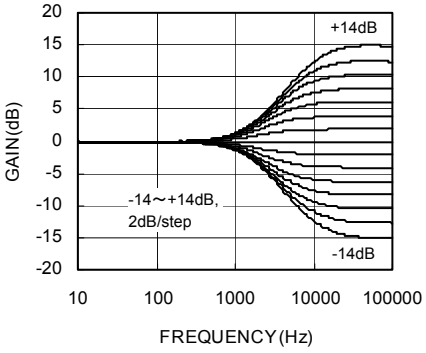


Fig.15 Treble Gain - Frequency

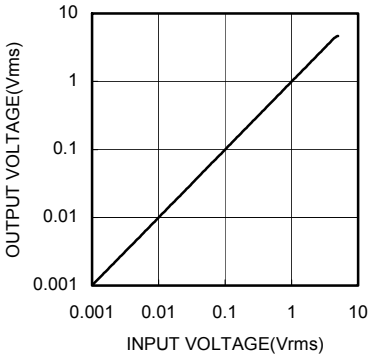


Fig.16 REC Output Voltage - Input Voltage

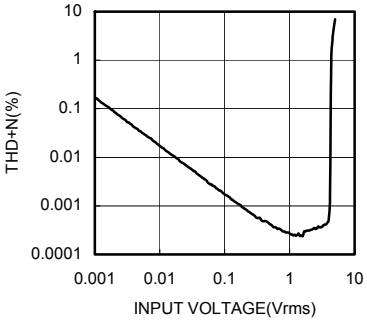


Fig.17 REC Total Harmonic Distortion - Input Voltage

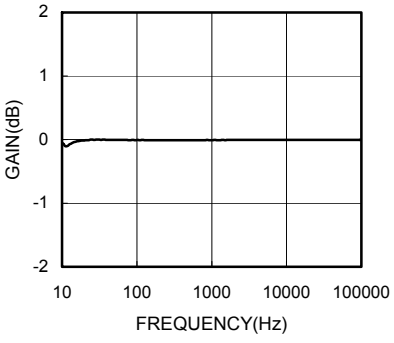


Fig.18 REC Voltage Gain - Frequency

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1. Numbers and data in entries are representative design values and are not guaranteed values of the items.

2. Although ROHM is confident that the example application circuit reflects the best possible recommendations, be sure to verify circuit characteristics for your particular application. Modification of constants for other externally connected circuits may cause variations in both static and transient characteristics for external components as well as this Rohm IC. Allow for sufficient margins when determining circuit constants.

3. Absolute maximum ratings
   Use of the IC in excess of absolute maximum ratings, such as the applied voltage or operating temperature range (Topr), may result in IC damage. Assumptions should not be made regarding the state of the IC (short mode or open mode) when such damage is suffered. A physical safety measure, such as a fuse, should be implemented when using the IC at times where the absolute maximum ratings may be exceeded.

4. VEE potential
   Make the VEE pin voltage such that it is the lowest voltage even when operating below it. Actually confirm that the voltage of each pin does not become a lower voltage than the VEE pin, including transient phenomena.

5. Thermal design
   Perform thermal design, in which there are adequate margins, by taking into account the power dissipation (Pd) in actual states of use.

6. Short circuit between terminals and erroneous mounting
   Pay attention to the assembly Direction of the ICs. Wrong mounting Direction or shorts between terminals, GND, or other components on the circuits, can damage the IC.

7. Operation in strong electromagnetic field
   Using the ICs in a strong electromagnetic field can cause operation malfunction.

8. Operating Voltage Range and Operating Temperature Range
   The circuit functional operations are guaranteed within the Operating Voltage Range and Operating Temperature Range. The standard values of electrical characteristics, however, are guaranteed under the specific conditions. Accordingly, careful consideration of the IC characteristic variations is required to design a set of circuit.

9. Power ON/OFF
   (a) At power ON/OFF, a shock sound will be generated. Therefore, use MUTE on the set.
   (b) When turning on power supplies, VEE and VCC should be powered on simultaneously, or VEE first followed by VCC. If the VCC side is started up first, an excessive current may flow from VCC to VEE.

10. Serial control
    For the CL and DA terminals, the patterned and other wirings should be routed as not to cause interference with the analog-signal-related lines.

11. Function switching
    For the all functions other than Master Volume, Treble, and Bass Gain Settings, use MUTE on the set.

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●Ordering part number

B	D	3	8	1	6	K	1		

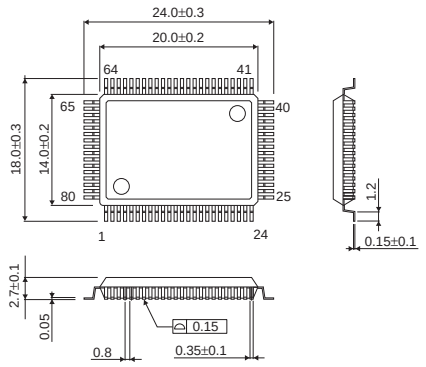
Part No.

Part No.
3816
3817

Package
K1: QFP80
KS: SQFP100

Packaging and forming specification
None:Tray

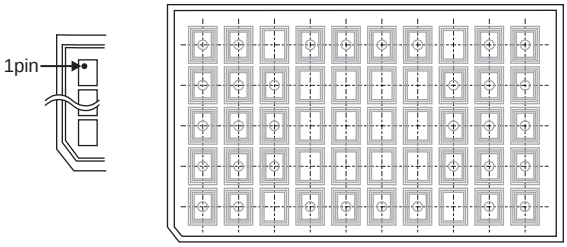
QFP80



(Unit : mm)

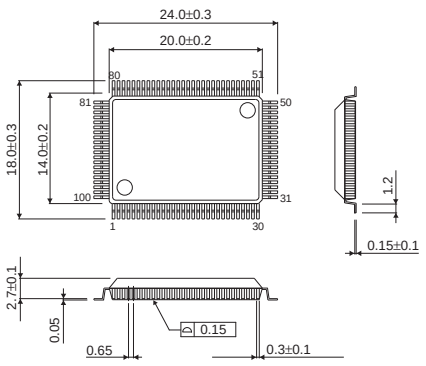
<Tape and Reel information>

Container	Tray (with dry pack)
Quantity	500pcs
Direction of feed	Direction of product is fixed in a tray



∗Order quantity needs to be multiple of the minimum quantity.

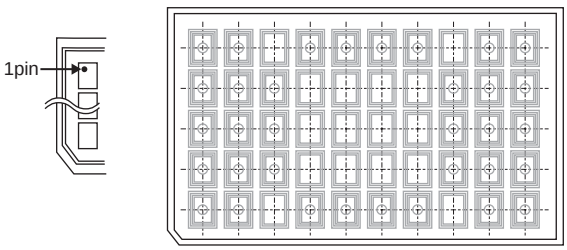
SQFP100



(Unit : mm)

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Container	Tray (with dry pack)
Quantity	500pcs
Direction of feed	Direction of product is fixed in a tray



∗Order quantity needs to be multiple of the minimum quantity.

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