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

●Absolute maximum ratings (Ta=25℃)

Parameter	Symbol	Ratings		Unit
Power Supply Voltage	Vcc	7.5 [*1]		V
	VEE	-7.5		
Power Dissipation	Pd	1200 (BD3816K1) 1300 (BD3817KS)	[*2]	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	Vcc	5.0	7.0	7.3	V
	VEE	-7.3	-7.0	-5.0	

●Electrical characteristics
Ta=25℃, Vcc=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

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.

2010.06 - Rev.A

●**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.
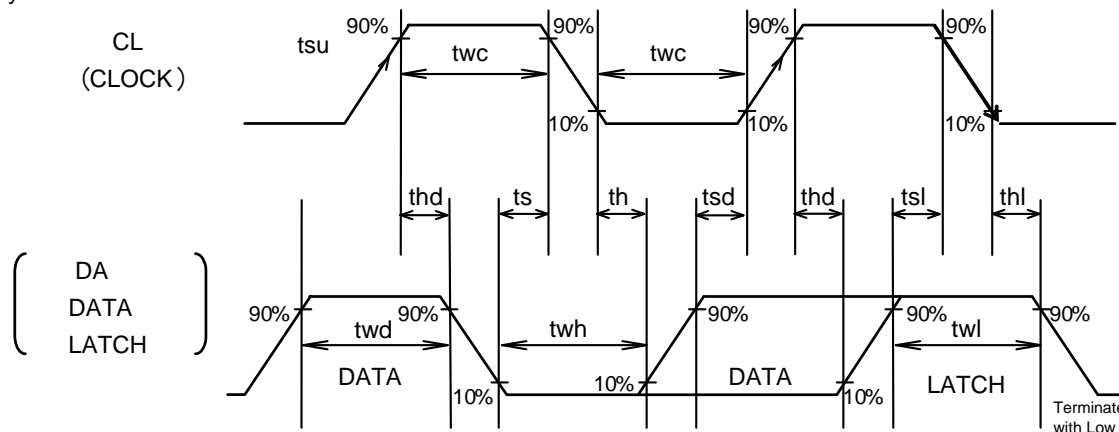　　　* To avoid malfunctions, clock and data signals must terminate with the LOW state.

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

3) Control Data Format List

← Data input Direction

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

(1)BD3816K1 Control Data Formats | Select Address

	D16	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
Data ①	FRL select		6.1ch select		Input select			0					0	0	0	0	0

	D16	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
Data ②	REC A mode select		REC B	REC C	Output mode select		0						0	1	0	0	0

	D16	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
Data ③	Treble				Bass				Mixing Cch		Mixing SWch		1	0	0	0	0

	D16	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
Data ④	Input gain FRLch			Input gain SRLch			Input gain Cch			Input gain CBch			1	1	0	0	0

	D16	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
Data ⑤	Master volume and Output gain SWch								Input gain SWch			0			0	0	1

	D16	D15	D14	D13	D12	D11	D0	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
Data ⑥	Master volume and Output gain FRch								Master volume and Output gain FLch						0	1	0

	D16	D15	D14	D13	D12	D11	D0	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
Data ⑦	Master volume and Output gain SRch								Master volume and Output gain SLch						0	1	1

	D16	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
Data ⑧	Master volume and Output gain Cch								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.

(2)BD3817K1 Control Data Formats | Select Address

Data ①	D16	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
	FRL select		6.1ch select		Input select1				Input select2				0	0	0	0	0

Data ②	D16	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
	REC A mode select		REC B	REC C	Output mode select		0						0	1	0	0	0

Data ③	D16	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
	Treble				Bass				Mixing Cch		Mixing SWch		1	0	0	0	0

Data ④	D16	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
	Input gain FRLch				Input gain SRLch				Input gain Cch		Input gain CBch		1	1	0	0	0

Data ⑤	D16	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
	Master volume and Output gain SWch						Input gain SWch			0					0	0	1

Data ⑥	D16	D15	D14	D13	D12	D11	D0	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
	Master volume and Output gain FRch						Master volume and Output gain FLch								0	1	0

Data ⑦	D16	D15	D14	D13	D12	D11	D0	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
	Master volume and Output gain SRch						Master volume and Output gain SLch								0	1	1

Data ⑧	D16	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
	Master volume and Output gain Cch						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		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.

●**Block diagram, application circuit**

1) BD3816K1

Fig. 2

UNIT
RESISTANCE : Ω
CAPACITOR:F
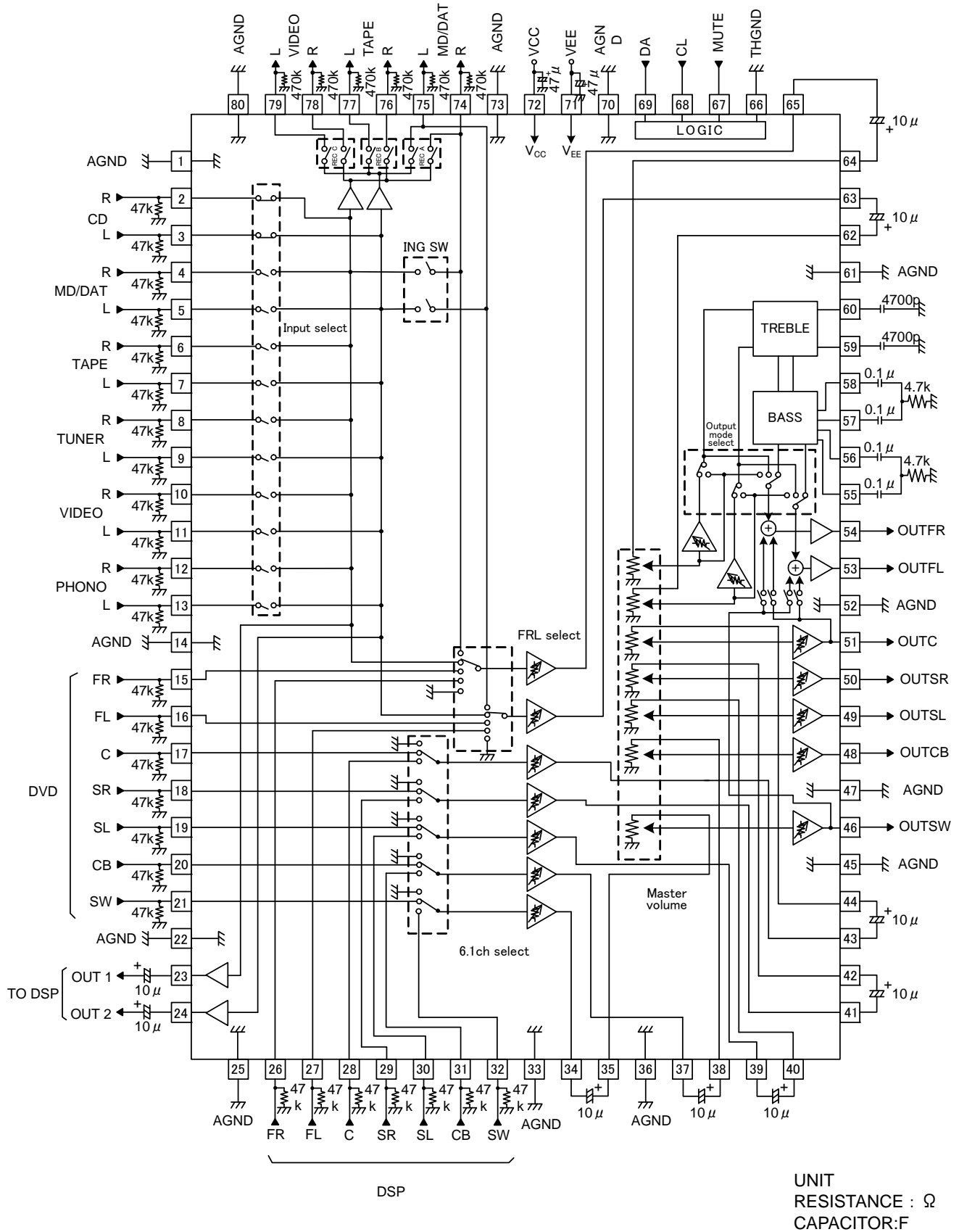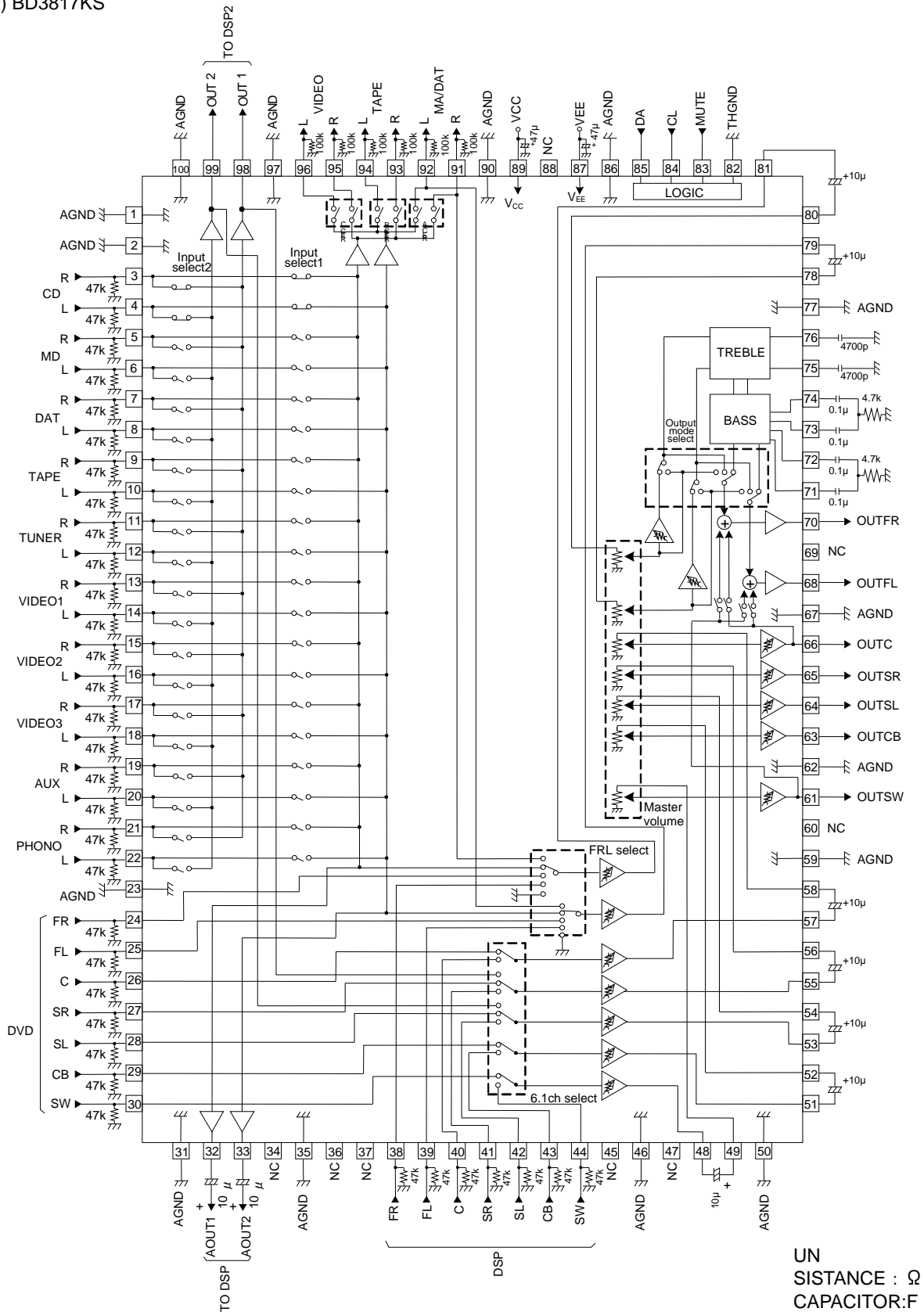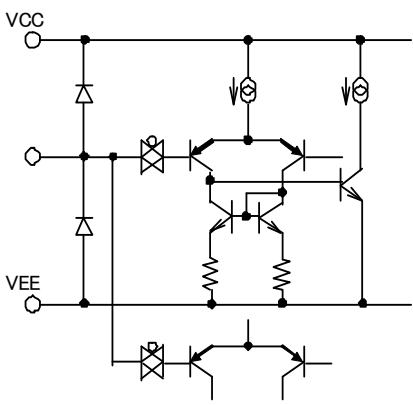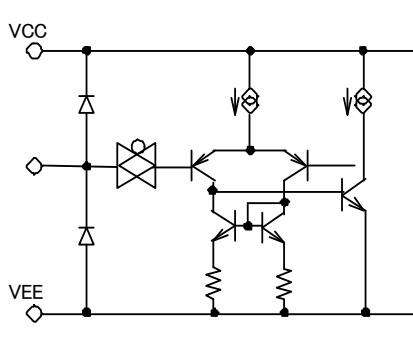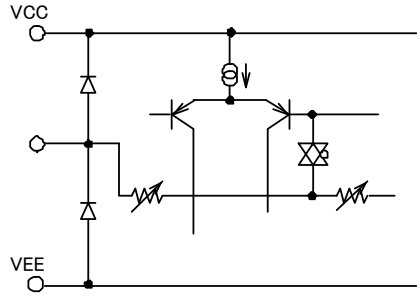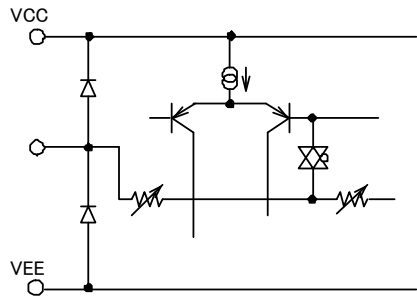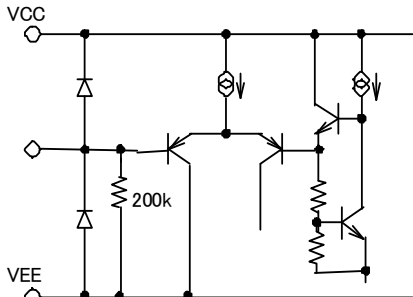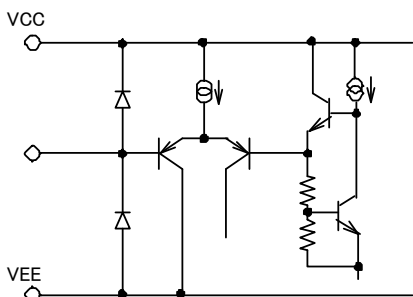
2) BD3817KS

Fig. 3

●**Equivalent circuit**

BD3816K1		BD3817KS		Pin Voltage	Equivalent circuit	Description
Pin No.	Pin Name	Pin No.	Pin Name			
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.

BD3816K1		BD3817KS		Pin Voltage	Equivalent circuit	Description
Pin No.	Pin Name	Pin No.	Pin Name			
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

BD3816K1		BD3817KS		Pin Voltage	Equivalent circuit	Description
Pin No.	Pin Name	Pin No.	Pin Name			
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

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

                                                                                   2010.06 - Rev.A

●**Setting constants for tone control filters**
   1) Treble filter
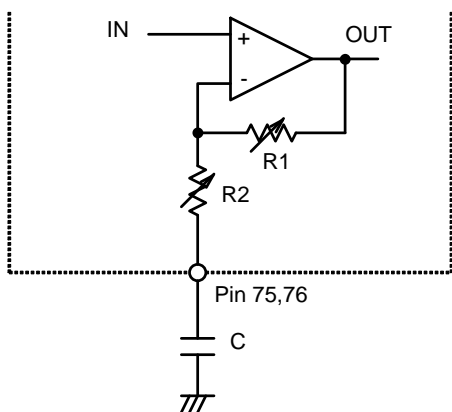
$$fc = \frac{1}{2\pi R2C} \quad (Hz)$$

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

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

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.
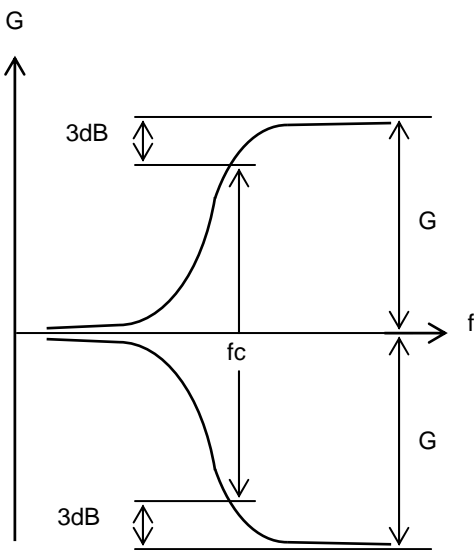
Fig. 5

2) Bass filter
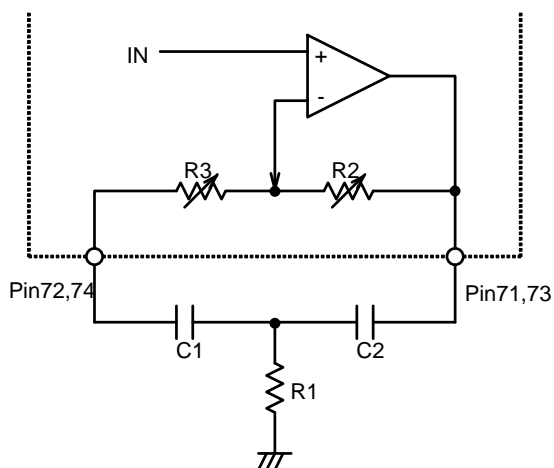
Fig. 6

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

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

When C1=C2

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

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.
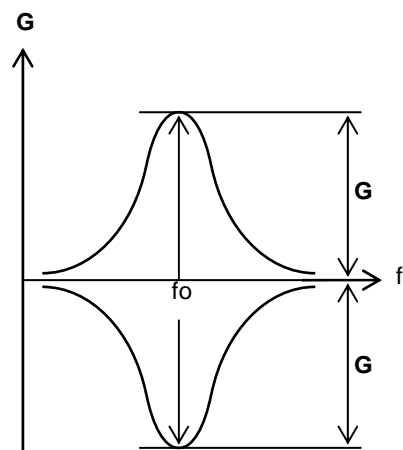
Fig. 7

* 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

●**Reference data**
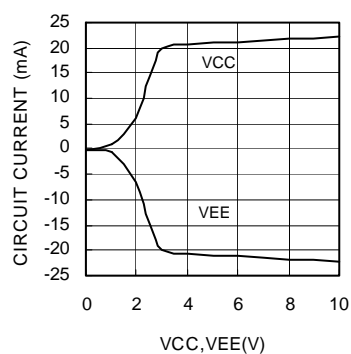
Fig.8 Circuit Current - Voltage Supply
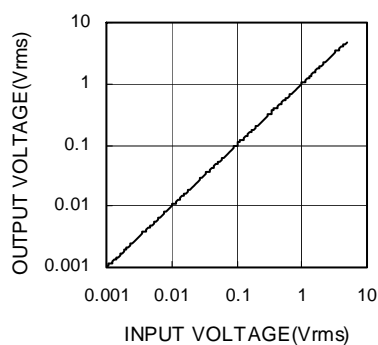
Fig.9 Output Voltage - Input Voltage
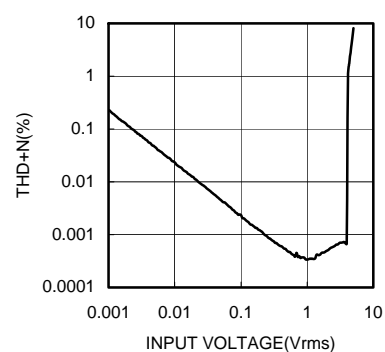
Fig.10 Total Harmonic Distortion - Input Voltage
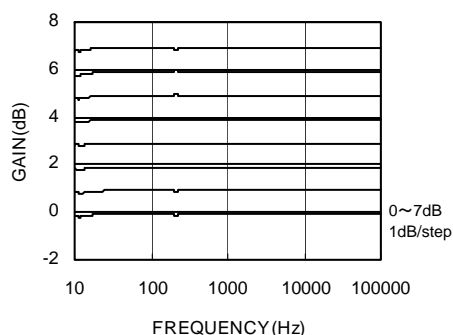
Fig.11 Input Gain - Frequency
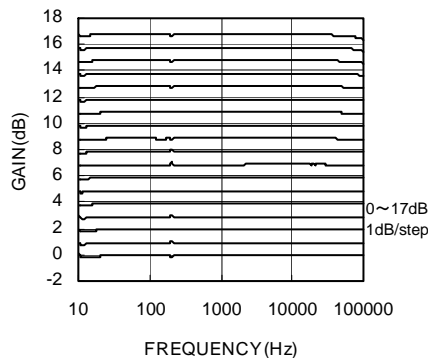
Fig.12 Output Gain - Frequency
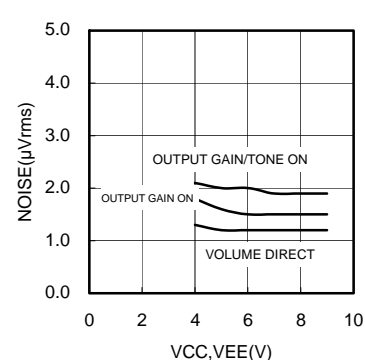
Fig.13 Output Noise Voltage - Power Supply Voltage
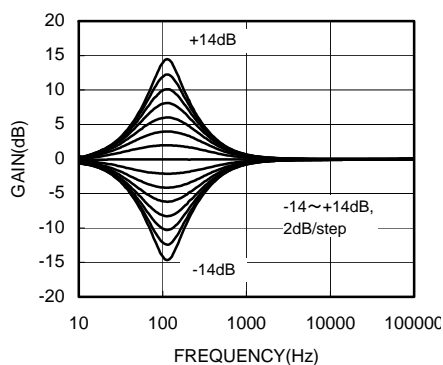
Fig.14 Bass Gain - Frequency
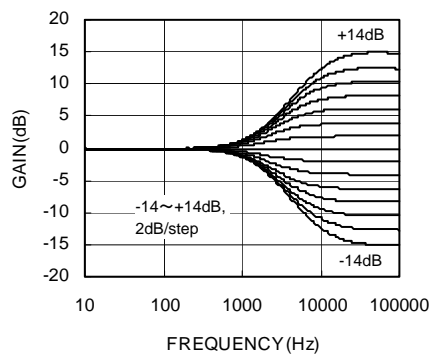
Fig.15 Treble Gain - Frequency
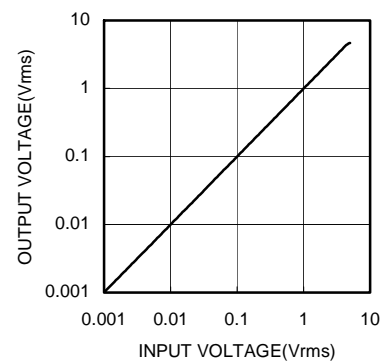
Fig.16 REC Output Voltage - Input Voltage
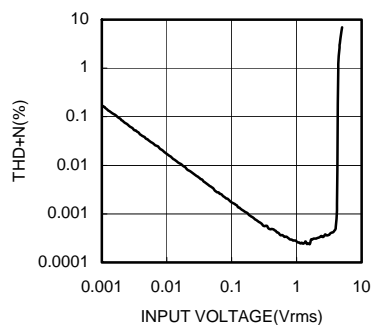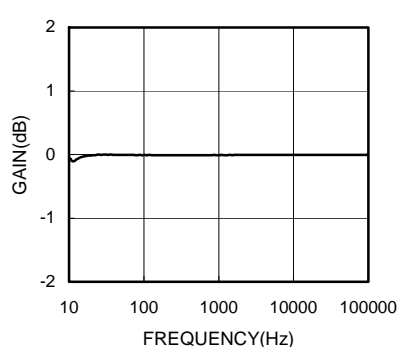
Fig.17 REC Total Harmonic Distortion - Input Voltage

Fig.18 REC Voltage Gain - Frequency

●**Notes for use**

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.

● **Ordering part number**

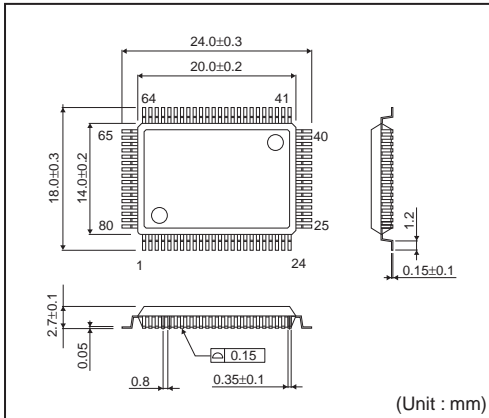| B	D		3	8	1	6		K	1			

Part No.

Part No.
3816
3817

Package
K1: QFP80
KS: SQFP100
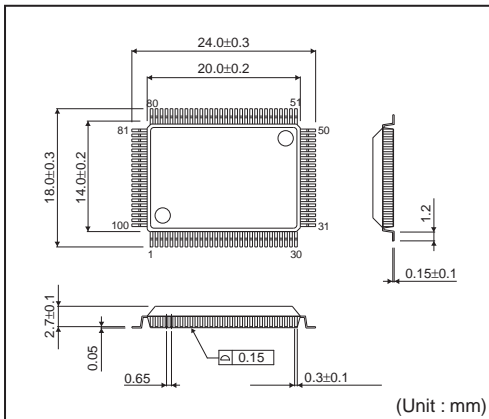
Packaging and forming specification
None:Tray

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

1pin
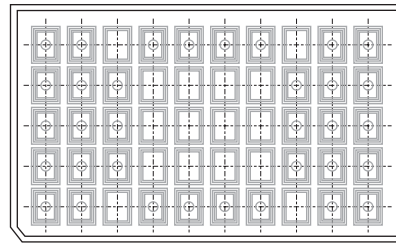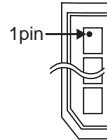
＊Order quantity needs to be multiple of the minimum quantity.

SQFP100

(Unit : mm)

<Tape and Reel information>

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

1pin
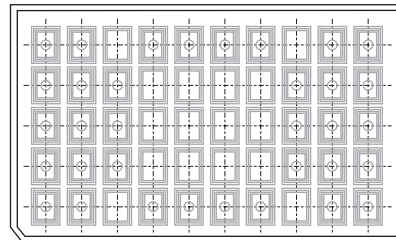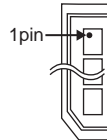
＊Order quantity needs to be multiple of the minimum quantity.

Notice

Precaution on using ROHM Products

1. Our Products are designed and manufactured for application in ordinary electronic equipments (such as AV equipment, OA equipment, telecommunication equipment, home electronic appliances, amusement equipment, etc.). If you intend to use our Products in devices requiring extremely high reliability (such as medical equipment [(Note 1)], transport equipment, traffic equipment, aircraft/spacecraft, nuclear power controllers, fuel controllers, car equipment including car accessories, safety devices, etc.) and whose malfunction or failure may cause loss of human life, bodily injury or serious damage to property ("Specific Applications"), please consult with the ROHM sales representative in advance. Unless otherwise agreed in writing by ROHM in advance, ROHM shall not be in any way responsible or liable for any damages, expenses or losses incurred by you or third parties arising from the use of any ROHM's Products for Specific Applications.

(Note1) Medical Equipment Classification of the Specific Applications

JAPAN	USA	EU	CHINA
CLASSⅢ	CLASSⅢ	CLASSⅡb	CLASSⅢ
CLASSⅣ		CLASSⅢ	

2. ROHM designs and manufactures its Products subject to strict quality control system. However, semiconductor products can fail or malfunction at a certain rate. Please be sure to implement, at your own responsibilities, adequate safety measures including but not limited to fail-safe design against the physical injury, damage to any property, which a failure or malfunction of our Products may cause. The following are examples of safety measures:
   - [a] Installation of protection circuits or other protective devices to improve system safety
   - [b] Installation of redundant circuits to reduce the impact of single or multiple circuit failure

3. Our Products are designed and manufactured for use under standard conditions and not under any special or extraordinary environments or conditions, as exemplified below. Accordingly, ROHM shall not be in any way responsible or liable for any damages, expenses or losses arising from the use of any ROHM's Products under any special or extraordinary environments or conditions. If you intend to use our Products under any special or extraordinary environments or conditions (as exemplified below), your independent verification and confirmation of product performance, reliability, etc, prior to use, must be necessary:
   - [a] Use of our Products in any types of liquid, including water, oils, chemicals, and organic solvents
   - [b] Use of our Products outdoors or in places where the Products are exposed to direct sunlight or dust
   - [c] Use of our Products in places where the Products are exposed to sea wind or corrosive gases, including Cl_2, H_2S, NH_3, SO_2, and NO_2
   - [d] Use of our Products in places where the Products are exposed to static electricity or electromagnetic waves
   - [e] Use of our Products in proximity to heat-producing components, plastic cords, or other flammable items
   - [f] Sealing or coating our Products with resin or other coating materials
   - [g] Use of our Products without cleaning residue of flux (even if you use no-clean type fluxes, cleaning residue of flux is recommended); or Washing our Products by using water or water-soluble cleaning agents for cleaning residue after soldering
   - [h] Use of the Products in places subject to dew condensation

4. The Products are not subject to radiation-proof design.

5. Please verify and confirm characteristics of the final or mounted products in using the Products.

6. In particular, if a transient load (a large amount of load applied in a short period of time, such as pulse. is applied, confirmation of performance characteristics after on-board mounting is strongly recommended. Avoid applying power exceeding normal rated power; exceeding the power rating under steady-state loading condition may negatively affect product performance and reliability.

7. De-rate Power Dissipation (Pd) depending on Ambient temperature (Ta). When used in sealed area, confirm the actual ambient temperature.

8. Confirm that operation temperature is within the specified range described in the product specification.

9. ROHM shall not be in any way responsible or liable for failure induced under deviant condition from what is defined in this document.

Precaution for Mounting / Circuit board design

1. When a highly active halogenous (chlorine, bromine, etc.) flux is used, the residue of flux may negatively affect product performance and reliability.

2. In principle, the reflow soldering method must be used; if flow soldering method is preferred, please consult with the ROHM representative in advance.

For details, please refer to ROHM Mounting specification

Precautions Regarding Application Examples and External Circuits

1. If change is made to the constant of an external circuit, please allow a sufficient margin considering variations of the characteristics of the Products and external components, including transient characteristics, as well as static characteristics.

2. You agree that application notes, reference designs, and associated data and information contained in this document are presented only as guidance for Products use. Therefore, in case you use such information, you are solely responsible for it and you must exercise your own independent verification and judgment in the use of such information contained in this document. ROHM shall not be in any way responsible or liable for any damages, expenses or losses incurred by you or third parties arising from the use of such information.

Precaution for Electrostatic

This Product is electrostatic sensitive product, which may be damaged due to electrostatic discharge. Please take proper caution in your manufacturing process and storage so that voltage exceeding the Products maximum rating will not be applied to Products. Please take special care under dry condition (e.g. Grounding of human body / equipment / solder iron, isolation from charged objects, setting of Ionizer, friction prevention and temperature / humidity control).

Precaution for Storage / Transportation

1. Product performance and soldered connections may deteriorate if the Products are stored in the places where:
   [a] the Products are exposed to sea winds or corrosive gases, including Cl2, H2S, NH3, SO2, and NO2
   [b] the temperature or humidity exceeds those recommended by ROHM
   [c] the Products are exposed to direct sunshine or condensation
   [d] the Products are exposed to high Electrostatic

2. Even under ROHM recommended storage condition, solderability of products out of recommended storage time period may be degraded. It is strongly recommended to confirm solderability before using Products of which storage time is exceeding the recommended storage time period.

3. Store / transport cartons in the correct direction, which is indicated on a carton with a symbol. Otherwise bent leads may occur due to excessive stress applied when dropping of a carton.

4. Use Products within the specified time after opening a humidity barrier bag. Baking is required before using Products of which storage time is exceeding the recommended storage time period.

Precaution for Product Label

QR code printed on ROHM Products label is for ROHM's internal use only.

Precaution for Disposition

When disposing Products please dispose them properly using an authorized industry waste company.

Precaution for Foreign Exchange and Foreign Trade act

Since our Products might fall under controlled goods prescribed by the applicable foreign exchange and foreign trade act, please consult with ROHM representative in case of export.

Precaution Regarding Intellectual Property Rights

1. All information and data including but not limited to application example contained in this document is for reference only. ROHM does not warrant that foregoing information or data will not infringe any intellectual property rights or any other rights of any third party regarding such information or data. ROHM shall not be in any way responsible or liable for infringement of any intellectual property rights or other damages arising from use of such information or data.:

2. No license, expressly or implied, is granted hereby under any intellectual property rights or other rights of ROHM or any third parties with respect to the information contained in this document.

Other Precaution

1. This document may not be reprinted or reproduced, in whole or in part, without prior written consent of ROHM.

2. The Products may not be disassembled, converted, modified, reproduced or otherwise changed without prior written consent of ROHM.

3. In no event shall you use in any way whatsoever the Products and the related technical information contained in the Products or this document for any military purposes, including but not limited to, the development of mass-destruction weapons.

4. The proper names of companies or products described in this document are trademarks or registered trademarks of ROHM, its affiliated companies or third parties.

General Precaution

1. Before you use our Pro ducts, you are requested to care fully read this document and fully understand its contents. ROHM shall n ot be in an y way responsible or liabl e for fa ilure, malfunction or acci dent arising from the use of a ny ROHM's Products against warning, caution or note contained in this document.

2. All information contained in this docume nt is current as of the issuing date and subj ect to change without any prior notice. Before purchasing or using ROHM's Products, please confirm the la test information with a ROHM sale s representative.

3. The information contained in this doc ument is provi ded on an "as is" basis and ROHM does not warrant that all information contained in this document is accurate an d/or error-free. ROHM shall not be in an y way responsible or liable for an y damages, expenses or losses incurred b y you or third parties resulting from inaccur acy or errors of or concerning such information.