Headphone Amplifiers

Coupling Capacitorless Headphone Amplifiers

BD88200GUL,BD88210GUL,BD88215GUL,BD88220GUL

No.11102EAT04

●Description

BD88xxxGUL is output coupling capacitorless headphone amplifier. This IC has a negative voltage generator of regulated type built-in and generates the direct regulated negative voltage from the supply voltage. It is possible to drive headphones in a ground standard with both voltage of the positive voltage (+2.4V) and the negative voltage (-2.4V). Therefore a large-capacity output coupling capacitor becomes needless and can reduce a cost, a board area, and the height of the part. In addition, there is not the signal decrement by the low range to happen by output coupling capacitor and output load impedance and can output a rich low tone.
And, the function “Virtual ground” is embedded. Noise between IC and Headphone jack can be canceled by using “Virtual ground” function.

●Features

1) 2.4V to 5.5V Single-Supply Operation
2) No Bulky DC-Blocking Capacitors Required
3) No Degradation of Low-Frequency Response Due to Output Capacitors
4) Virtual Ground-Referenced Outputs
5) Gain setting
   BD88200GUL: Variable gain with external resistors
   BD88210GUL: -1.0V/V
   BD88215GUL: -1.5V/V
   BD88220GUL: -2.0V/V
6) Low THD+N
7) Low Supply Current
8) Integrated Negative Power Supply
9) Integrated Short-Circuit and Thermal-Overload Protection
10) Small package
   VCSP50L2 (2.1mm x 2.1mm)

●Applications

Mobile Phones, Smart Phones, PDAs, Portable Audio Players, PCs, TVs, Digital Cameras, Digital Video Cameras, Electronic Dictionaries, Voice Recorders, Bluetooth Head-sets, etc

●Line up

Type	Supply Voltage [V]	Supply Current [mA]	Gain [V/V]	Maximum Output Power [mW]	THD+N [%]	Noise Voltage [μVrms]	PSRR [dB]	Package
BD88200GUL	2.4～5.5	2.0 (No signal)	Variable gain with external resister	80 (VDD=3.3V,RL=16Ω THD+N≦1%,f=1kHz)	0.006 (VDD=3.3V,RL=16Ω Po=10mW,f=1kHz)	10	-80 (f=217Hz)	VCSP50L2 (2.1mm x 2.1mm)
BD88210GUL			-1.0					
BD88215GUL			-1.5					
BD88220GUL			-2.0					

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●**Absolute maximum ratings**

Parameter	Symbol	Ratings	Unit
SGND to PGND voltage	V_{GG}	0.0	V
SVDD to PVDD voltage	V_{DD}	-0.3 to 0.3	V
SVSS to PVSS voltage	V_{SS}	0.0	V
SGND or PGND to SVDD, PVDD voltage	V_{DG}	-0.3 to 6.0	V
SVSS, PVSS to SGND or PGND voltage	V_{SG}	-3.5 to 0.3	V
SGND to IN_- voltage	V_{IN}	(SVSS-0.3) to 2.8	V
SGND to OUT_- voltage	V_{OUT}	(SVSS-0.3) to 2.8	V
SGND to COM_- voltage	V_{COM}	(SVSS-0.3) to 2.8	V
PGND to C1P- voltage	V_{C1P}	(PGND-0.3) to (PVDD+0.3)	V
PGND to C1N- voltage	V_{C1N}	(PVSS-0.3) to (PGND+0.3)	V
SGND to SHDN_B- voltage	V_{SH}	(SGND-0.3) to (SVDD+0.3)	V
Input current	I_{IN}	-10 to 10	mA
Power Dissipation	P_D	1350 *	mW
Storage Temperature Range	T_{STG}	-55 to 150	℃

* In operating over 25 ℃, de-rate the value to 10.8mW/℃. This value is for mounted on the application board (Grass-epoxy, size: 40mm x 60mm, H=1.6mm, Top Copper area = 79.9%, Bottom Copper area = 80.2%).

●**Operating conditions**

Parameter	Symbol	Ratings			Unit
		Min.	Typ.	Max.	
Supply Voltage Range	V_{SVDD},V_{PVDD}	2.4	-	5.5	V
Operating Temperature Range	T_{OPR}	-40	-	+85	℃

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●Electrical characteristics

Unless otherwise specified, Ta=25℃, SVDD=PVDD=3.3V, SGND=PGND=0V, SHDNB=SVDD, C1=C2=2.2μF, RL=No Load, Ri=Rf=10kΩ

Parameter		Symbol	Limits			Unit	Conditions
			Min.	Typ.	Max.		
Supply Current							
Shutdown Supply Current		I_{ST}	-	0.1	2	μA	SHDNB=L
Quiescent Supply Current		I_{DD}	-	2.0	7.4	mA	SHDNB=H, No signal
SHDN_B Terminal							
H Level Input Voltage		V_{IH}	1.95	-	-	V	
L Level Input Voltage		V_{IL}	-	-	0.70	V	
Input Leak Current		I_{LEAK}	-	-	±1	μA	
Headphone Amplifier							
Shutdown to Full Operation		t_{SON}	-	80	-	μs	SHDNB=L→H
Offset Voltage		V_{IS}	-	±0.5	±5.0	mV	
Maximum Output Power		P_{OUT}	30	60	-	mW	RL=32Ω, THD+N≦1%, f=1kHz, 20kHz LPF, for Single Channel
			40	80	-	mW	RL=16Ω, THD+N≦1%, f=1kHz, 20kHz LPF, for Single Channel
Total Harmonic Distortion + Noise		THD+N	-	0.008	0.056	%	RL=32Ω, POUT=10mW, f=1kHz, 20kHz LPF
			-	0.006	0.100	%	RL=16Ω, POUT=10mW, f=1kHz, 20kHz LPF
Input Impedance		Z_{IN}	10	14	19	kΩ	SHDNB=H In BD88200GUL, ZIN = Ri
Gain	BD88200GUL	A_V	-	-1.00	-	V/V	In BD88200GUL, Gain is variable by the external resister of Ri and Rf.
	BD88210GUL		-1.05	-1.00	-0.95		
	BD88215GUL		-1.55	-1.50	-1.45		
	BD88220GUL		-2.06	-2.00	-1.94		
Gain match		ΔA_V	-	1	-	%	
Noise		V_N	-	10	-	μVrms	20kHz LPF + A-weight
Slew Rate		SR	-	0.15	-	V/μs	
Maximum Capacitive Load		CL	-	200	-	pF	
Crosstalk		CT	-	-90	-	dB	RL=32Ω, f=1kHz, VOUT=200mV_{P-P}, 1kHz BPF
Power Supply Rejection Ratio		PSRR	-	-80	-	dB	f=217Hz, 100mV_{P-P} - ripple, 217Hz BPF
Charge-Pump Oscillator Frequency		f_{OSC}	200	300	430	kHz	
Thermal-Shutdown Threshold		TSD	-	145	-	℃	
Thermal-Shutdown Hysteresis		T_{HYS}	-	5	-	℃	

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●Electrical characteristic curves – General Items (Reference data)

Unless otherwise specified, Ta=25℃, SGND=PGND=0V,SHDNB=SVDD, C1=C2=2.2µF,
Input coupling capacitor=1µF, RL=No Load * In BD88200GUL the input resister(Ri)=10kΩ, feedback resister(Rf)=10kΩ.

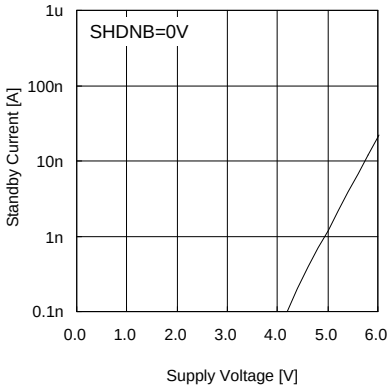


Fig.1 Standby Current vs. Supply Voltage

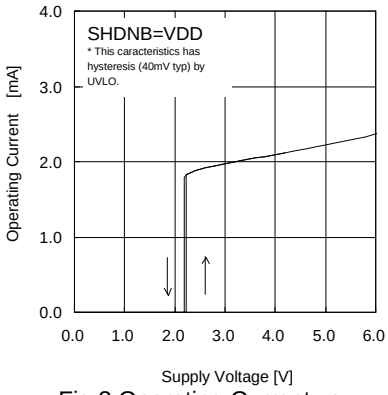


Fig.3 Operating Current vs. Supply voltage

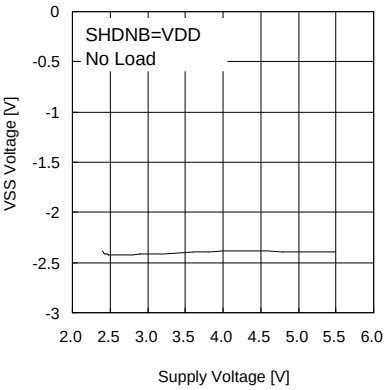


Fig.4 Negative Voltage vs. Supply Voltage

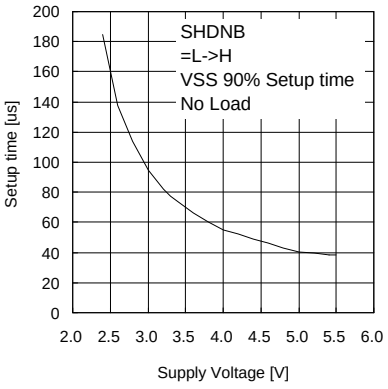


Fig.5 Setup time vs. Supply Voltage

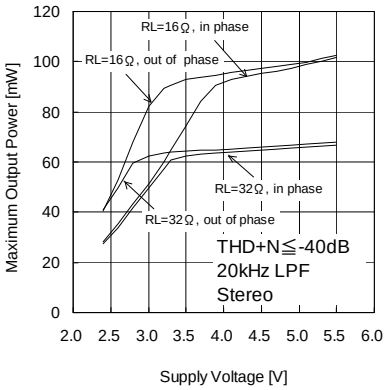


Fig.6 Maximum power vs. Supply Voltage

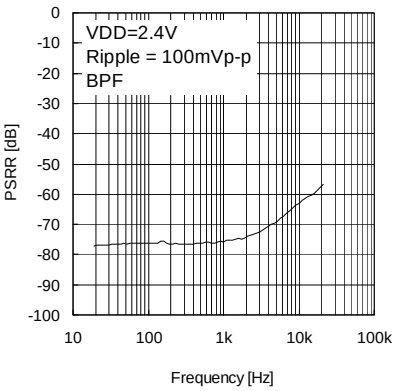


Fig.7 PSRR vs. Frequency (VDD=2.4V)

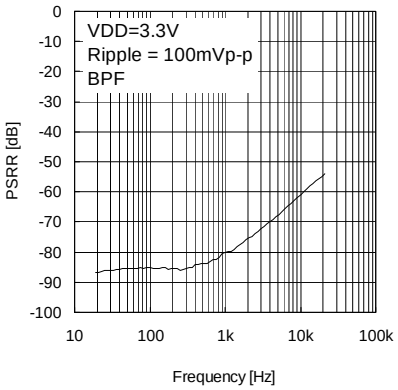


Fig.8 PSRR vs. Frequency (VDD=3.3V)

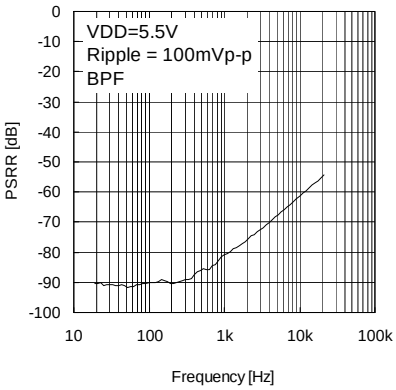


Fig.9 PSRR vs. Frequency (VDD=5.5V)

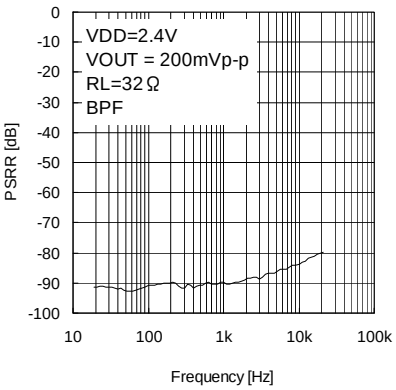


Fig.10 Crosstalk vs. Frequency (VDD=2.4V)

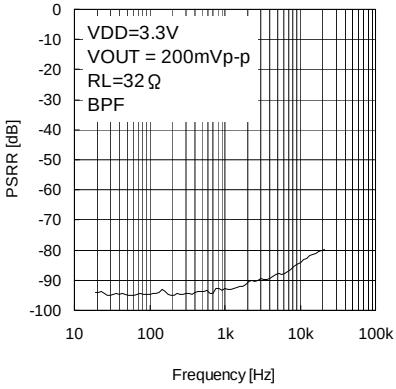


Fig.11 Crosstalk vs. Frequency (VDD=3.3V)

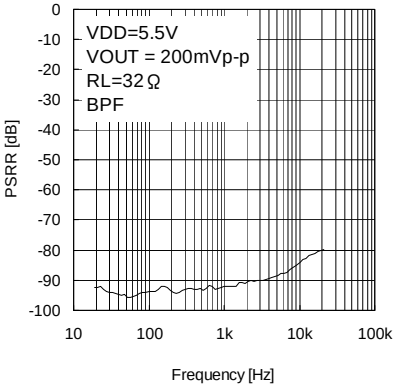


Fig.12 Crosstalk vs. Frequency (VDD=5.5V)

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●Electrical characteristic curves – BD88215GUL (Reference data)

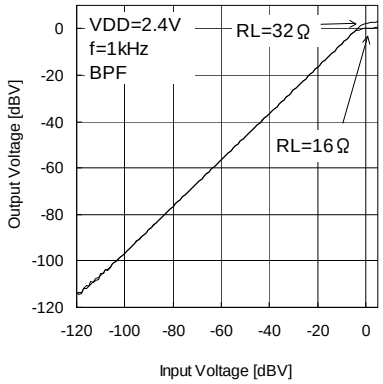


Fig.13 Output Voltage vs. Input Voltage (VDD=2.4V)

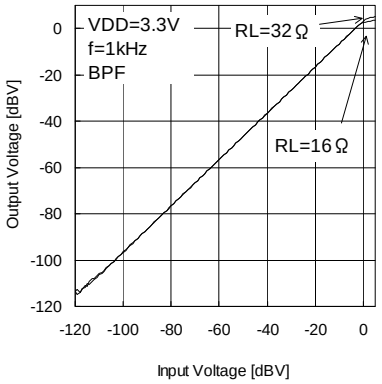


Fig.14 Output Voltage vs. Input Voltage (VDD=3.3V)

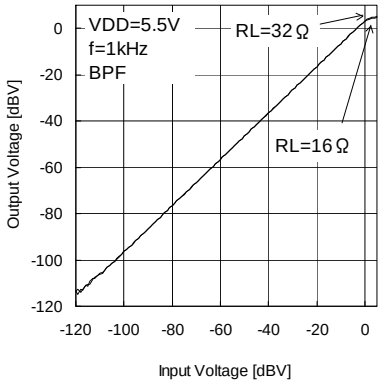


Fig.15 Output Voltage vs. Input Voltage (VDD=5.5V)

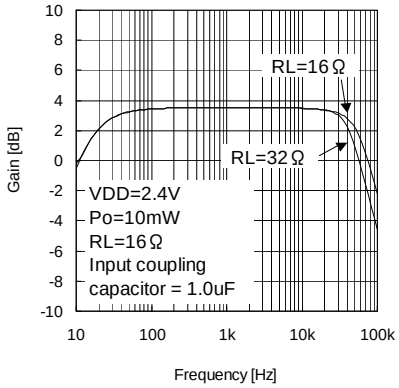


Fig.16 Gain vs. Frequency (VDD=2.4V)

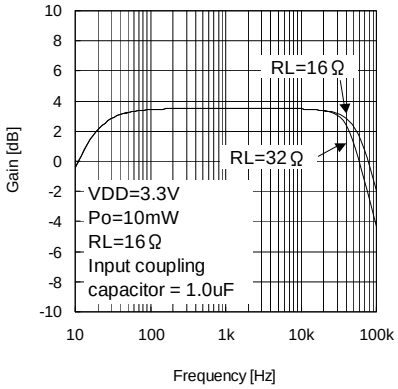


Fig.17 Gain vs. Frequency (VDD=3.3V)

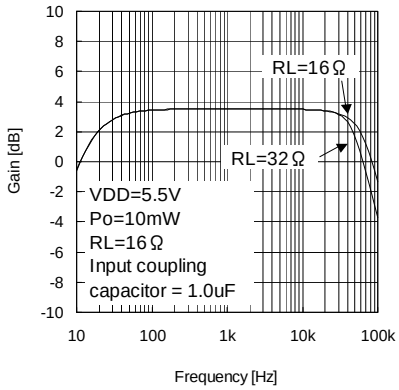


Fig.18 Gain vs. Frequency (VDD=5.5V)

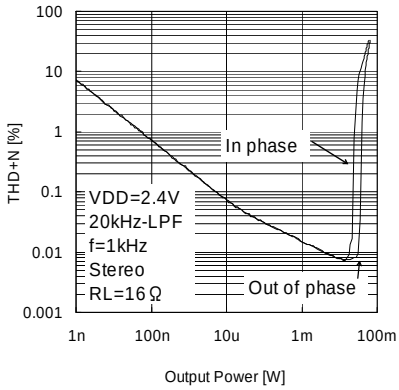


Fig.19 THD+N vs. Output Power (VDD=2.4V, RL=16Ω)

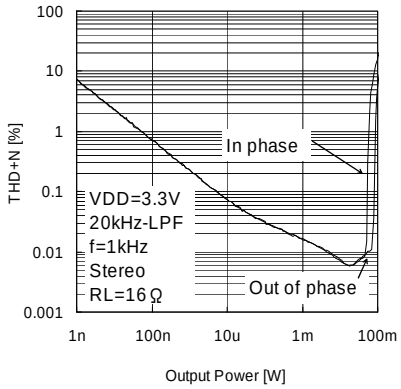


Fig.20 THD+N vs. Output Power (VDD=3.3V, RL=16Ω)

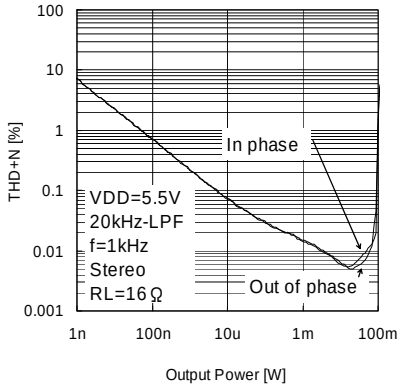


Fig.21 THD+N vs. Output Power (VDD=5.5V, RL=16Ω)

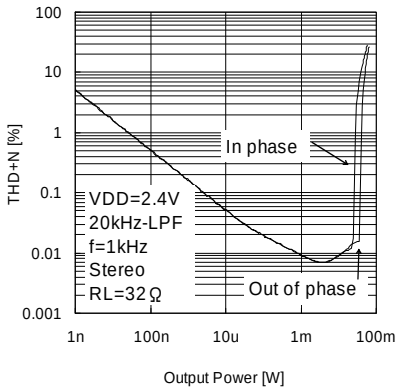


Fig.22 THD+N vs. Output Power (VDD=2.4V, RL=32Ω)

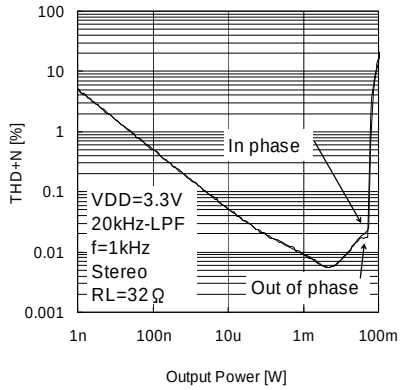


Fig.23 THD+N vs. Output Power (VDD=3.3V, RL=32Ω)

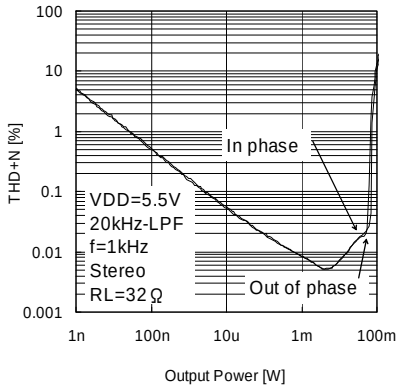


Fig.24 THD+N vs. Output Power (VDD=5.5V, RL=32Ω)

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●Electrical characteristic curves – BD88215GUL (Reference data) – Continued

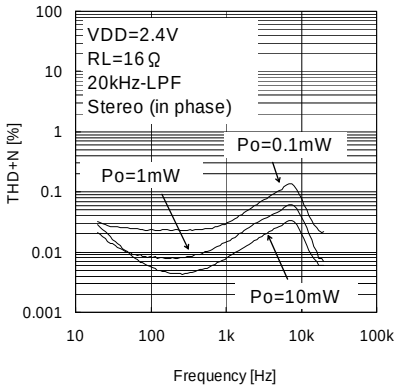


Fig.25 THD+N vs. Frequency
(VDD=2.4V, RL=16Ω)

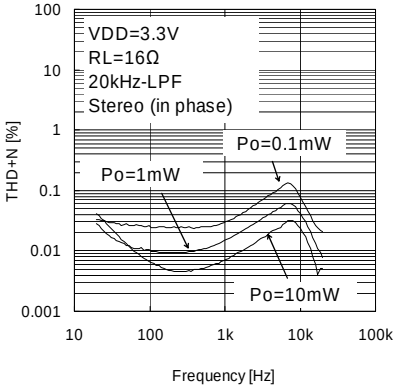


Fig. 26 THD+N vs. Frequency
(VDD=3.3V, RL=16Ω)

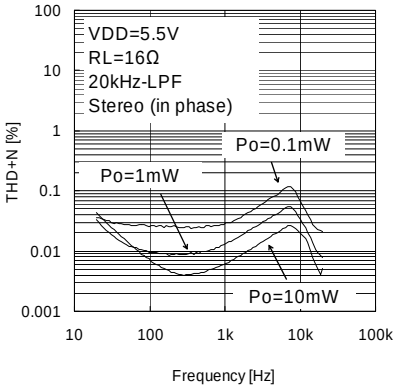


Fig. 27 THD+N vs. Frequency
(VDD=5.5V, RL=16Ω)

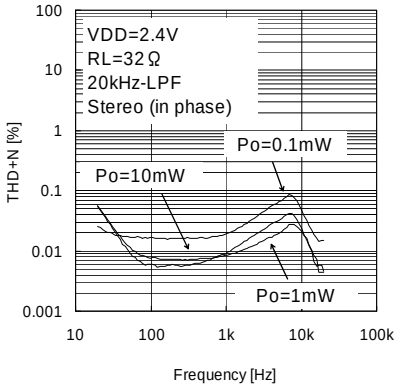


Fig. 28 THD+N vs. Frequency
(VDD=2.4V, RL=32Ω)

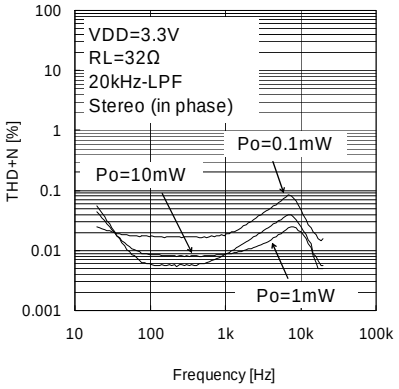


Fig. 29 THD+N vs. Frequency
(VDD=3.3V, RL=32Ω)

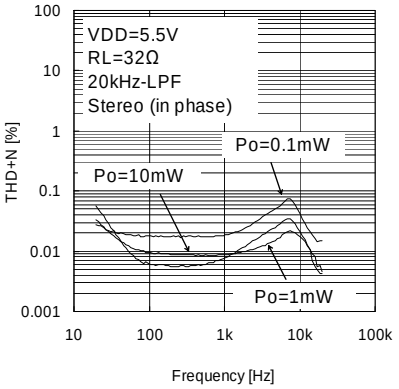


Fig. 30 THD+N vs. Frequency
(VDD=5.5V, RL=32Ω)

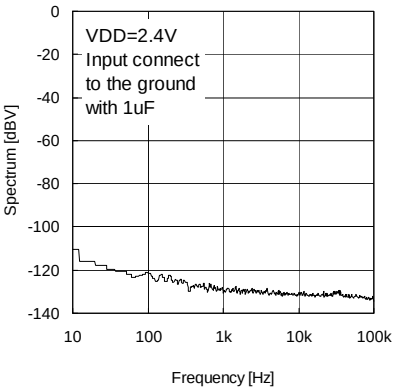


Fig.31 Noise Spectrum
(VDD=2.4V)

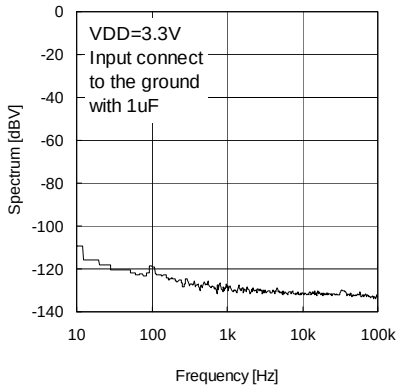


Fig.32 Noise Spectrum
(VDD=3.3V)

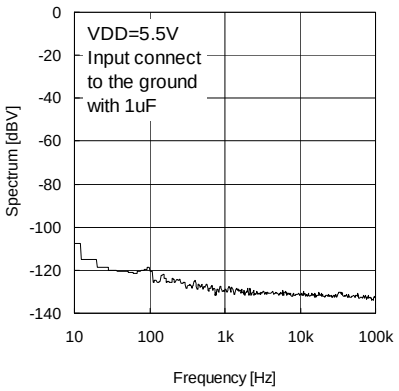


Fig.33 Noise Spectrum
(VDD=5.5V)

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●Electrical characteristic curves – BD88200GUL (Reference data)

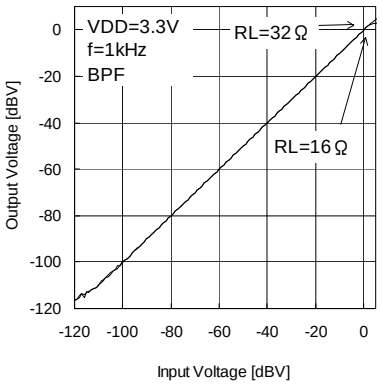


Fig.34 Output Voltage vs. Input Voltage (VDD=3.3V)

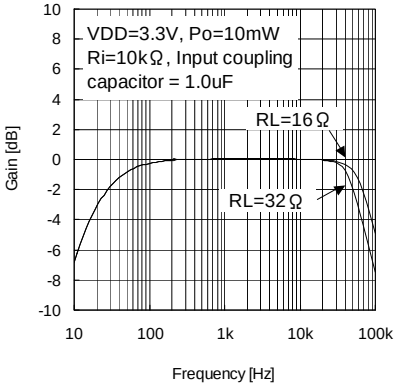


Fig.35 Gain vs. Frequency (VDD=3.3V)

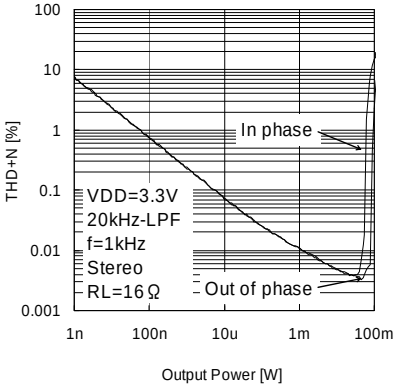


Fig.36 THD+N vs. Output Power (VDD=3.3V, RL=16Ω)

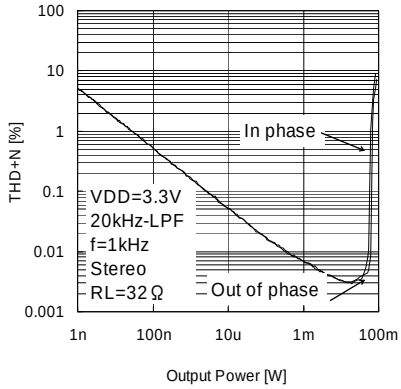


Fig. 37 THD+N vs. Output Power (VDD=3.3V, RL=32Ω)

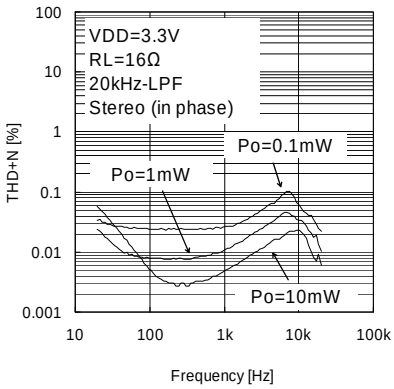


Fig.38 THD+N vs. Frequency (VDD=3.3V, RL=16Ω)

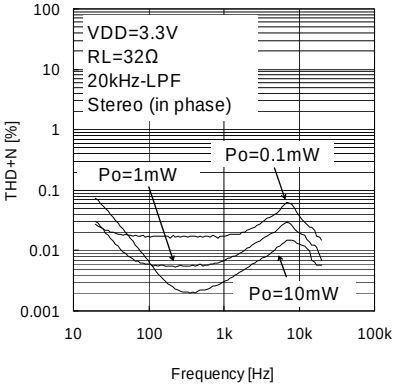


Fig. 39 THD+N vs. Frequency (VDD=3.3V, RL=32Ω)

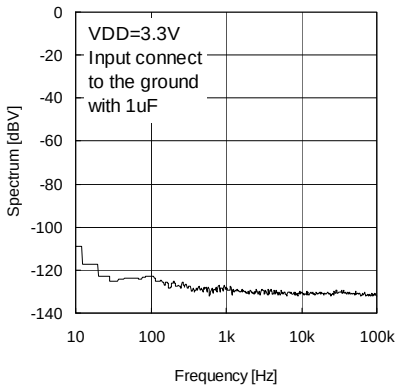


Fig.40 Noise Spectrum (VDD=3.3V)

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●Electrical characteristic curves – BD88210GUL (Reference data)

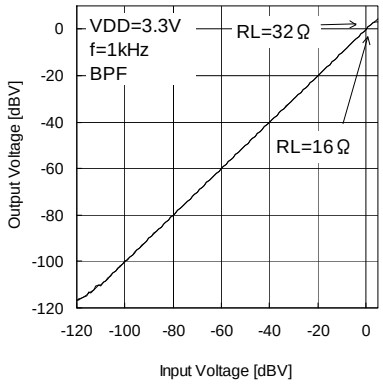


Fig.41 Output Voltage vs. Input Voltage (VDD=3.3V)

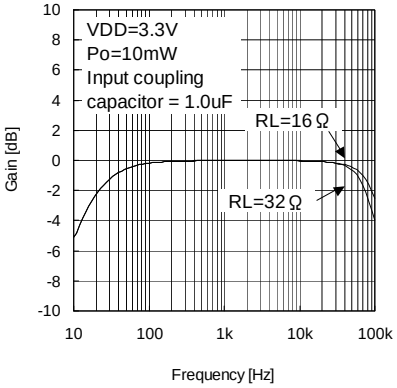


Fig.42 Gain vs. Frequency (VDD=3.3V)

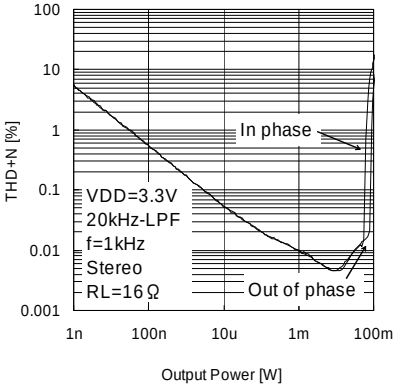


Fig.43 THD+N vs. Output Power (VDD=3.3V, RL=16Ω)

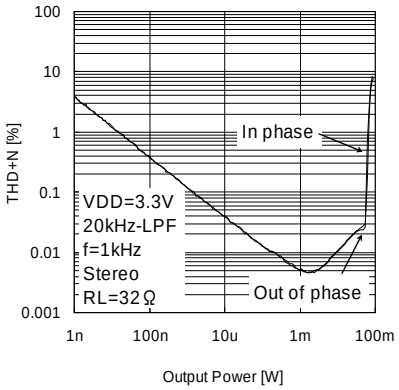


Fig. 44 THD+N vs. Output Power (VDD=3.3V, RL=32Ω)

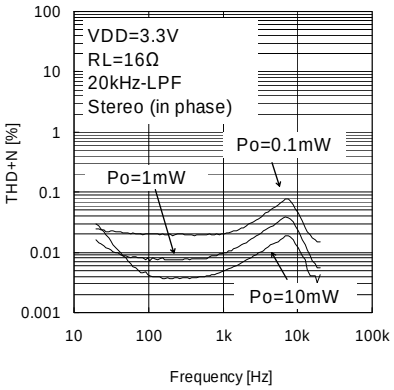


Fig.45 THD+N vs. Frequency (VDD=3.3V, RL=16Ω)

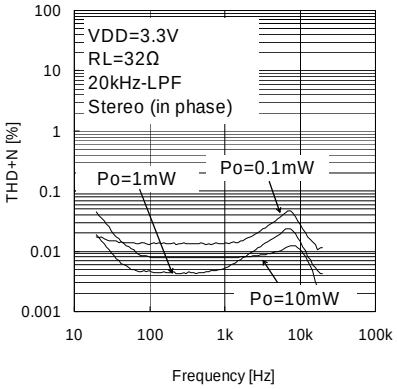


Fig. 46 THD+N vs. Frequency (VDD=3.3V, RL=32Ω)

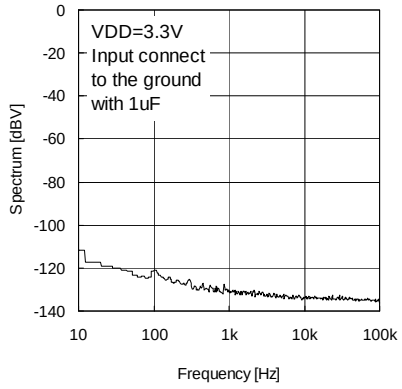


Fig.47 Noise Spectrum (VDD=3.3V)

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●Electrical characteristic curves – BD88220GUL (Reference data)

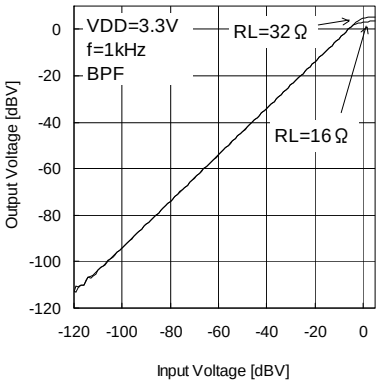


Fig.48 Output Voltage vs. Input Voltage (VDD=3.3V)

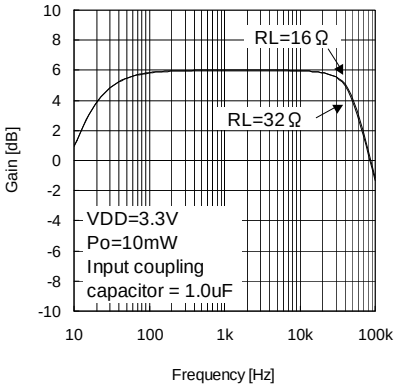


Fig.49 Gain vs. Frequency (VDD=3.3V)

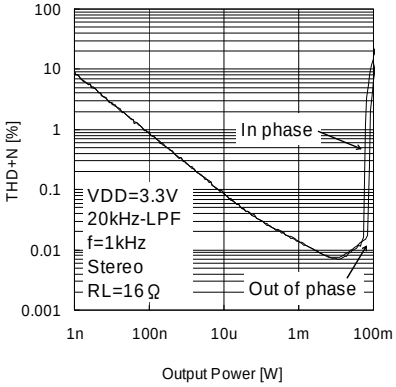


Fig.50 THD+N vs. Output Power (VDD=3.3V, RL=16Ω)

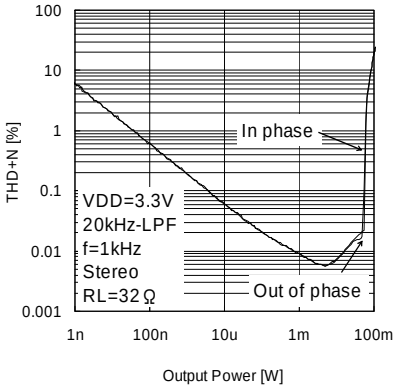


Fig. 51 THD+N vs. Output Power (VDD=3.3V, RL=32Ω)

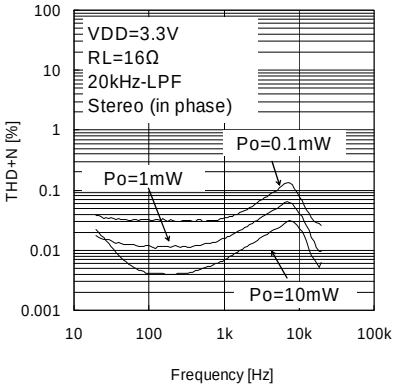


Fig.52 THD+N vs. Frequency (VDD=3.3V, RL=16Ω)

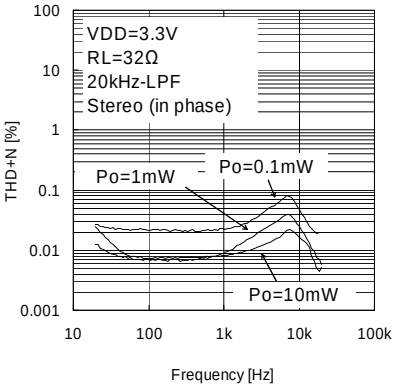


Fig. 53 THD+N vs. Frequency (VDD=3.3V, RL=32Ω)

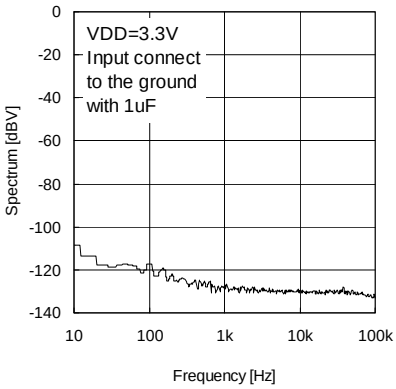


Fig.54 Noise Spectrum (VDD=3.3V)

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●Pin Arrangement

	1	2	3	4
D	SVDD	OUTL	SVSS	PVSS
C	INL	OUTR		C1N
B	SHDNB	COM		PGND
A	INR	SGND	PVDD	C1P

(Bottom View)

●Pin Function

Ball Matrix	Pin name	Function	Symbol
A1	INR	Headphone Amplifier (Rch) input	C
A2	SGND	Ground for Headphone Amplifier	-
A3	PVDD	Positive Power Supply for Charge Pump	-
A4	C1P	Flying Capacitor (CF) Positive	A
B1	SHDNB	Headphone Amplifier Shutdown Control (H:active, L:shutdown)	E
B2	COM	Virtual Ground Input	-
B4	PGND	Ground for Charge Pump	-
C1	INL	Headphone Amplifier (Lch) input	C
C2	OUTR	Headphone Amplifier (Rch) output	D
C4	C1N	Flying Capacitor (CF) Negative	B
D1	SVDD	Ground for Headphone Amplifier	-
D2	OUTL	Headphone Amplifier (Lch) output	D
D3	SVSS	Negative Supply Voltage for Signal	-
D4	PVSS	Negative Supply Voltage output	F

●Pin equivalent circuit

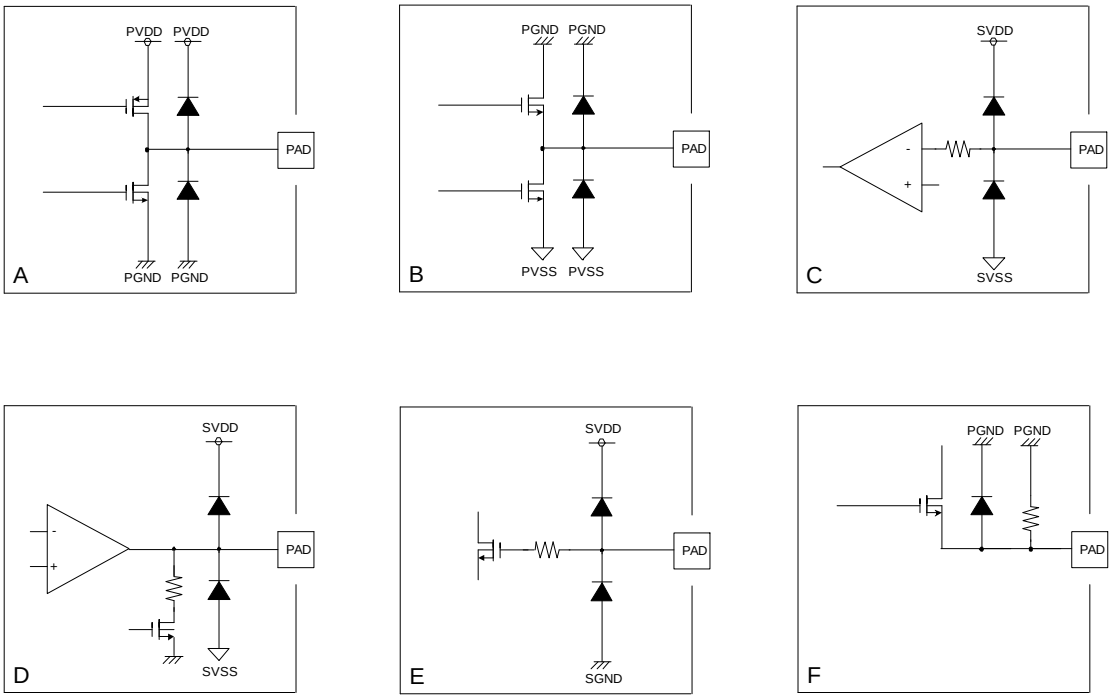
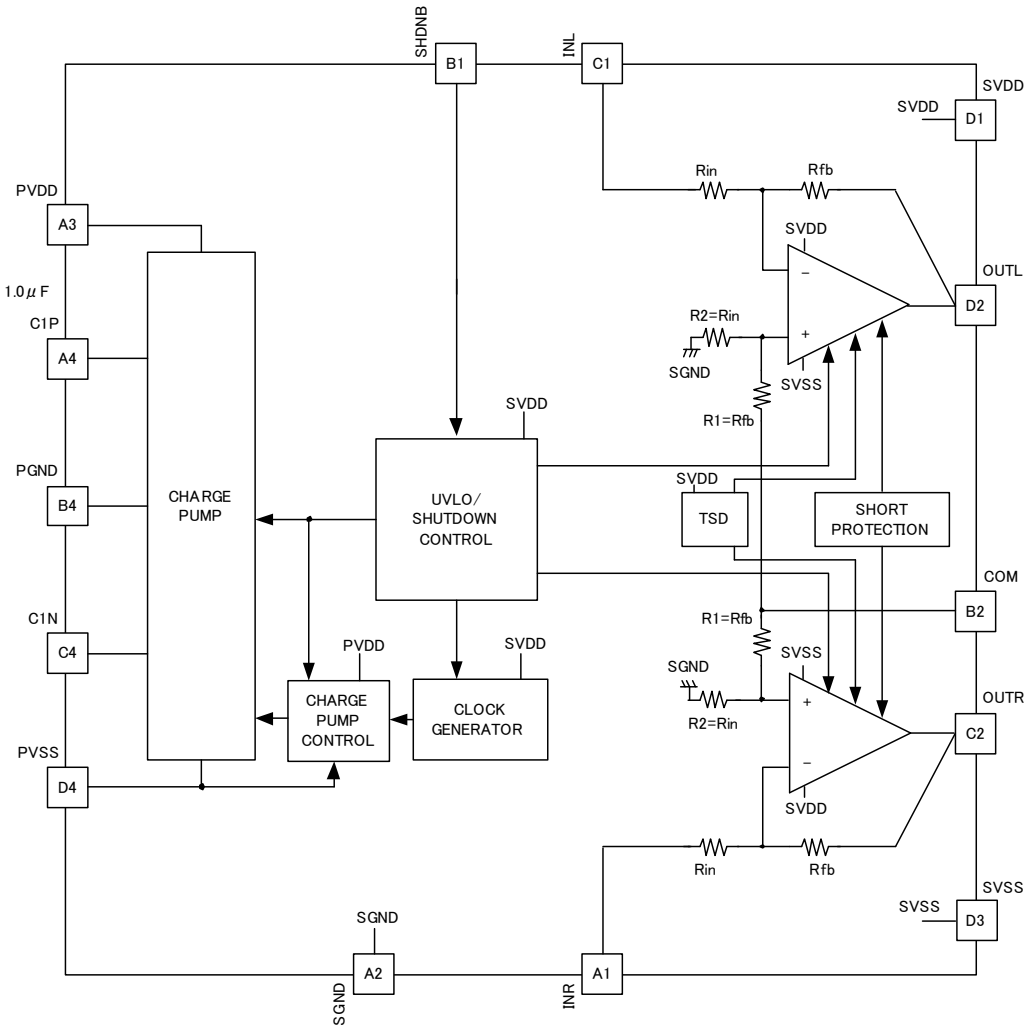


Fig.55 Pin equivalent circuit

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●Block Diagram



Type	Rin	Rfb
BD88200GUL	14kΩ @Typ.	Open
BD88210GUL	14kΩ @Typ.	14kΩ @Typ.
BD88215GUL	14kΩ @Typ.	21kΩ @Typ.
BD88220GUL	14kΩ @Typ.	28kΩ @Typ.

Fig.56 Block Diagram

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●Functional descriptions

The conventional headphone amplifier composition is occupied to Fig.57. In this composition, the signal is output by using the middle point bias circuit based on the middle point bias. Therefore, the output coupling capacitor that removes the DC voltage difference and does the AC coupling is necessary. This coupling capacitor and the impedance of the headphone composes the high-pass filter. Therefore, the signal degradation in the low frequency region learns by experience. The output coupling capacitor should be a large capacity, because the cutoff frequency of this high-pass filter becomes the following formula (1).

$$f_c = \frac{1}{2\pi R_L C_C} \quad (1)$$

* Cc is the coupling capacitor, and RL is the impedance of the headphone.

Moreover, POP noise by the middle point bias start-up is generated and the degradation of PSRR learns by experience.

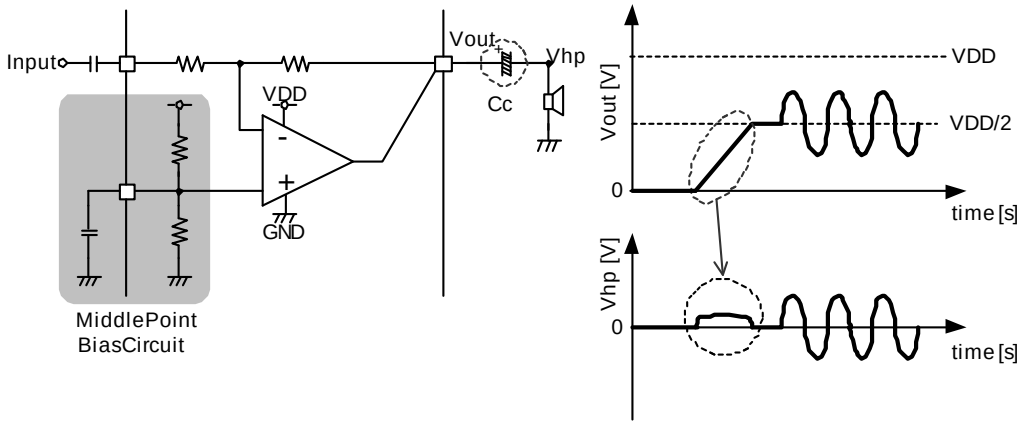


Fig.57 Conventional headphone amplifier composition

The composition of the series of BD882xxGUL is occupied to Fig.58. In this composition, the signal is output by using a negative voltage based on the ground level. Therefore, the amplifier output can be connected directly with the headphone. And, the output coupling capacitor becomes unnecessary. Additionally, the signal degradation in the low frequency region with the coupling capacitor is not generated, and the deep bass is achieved.
Moreover, POP noise is controlled because of no middle point bias start-up. And, the degradation of PSRR doesn't occur by being based on the ground.

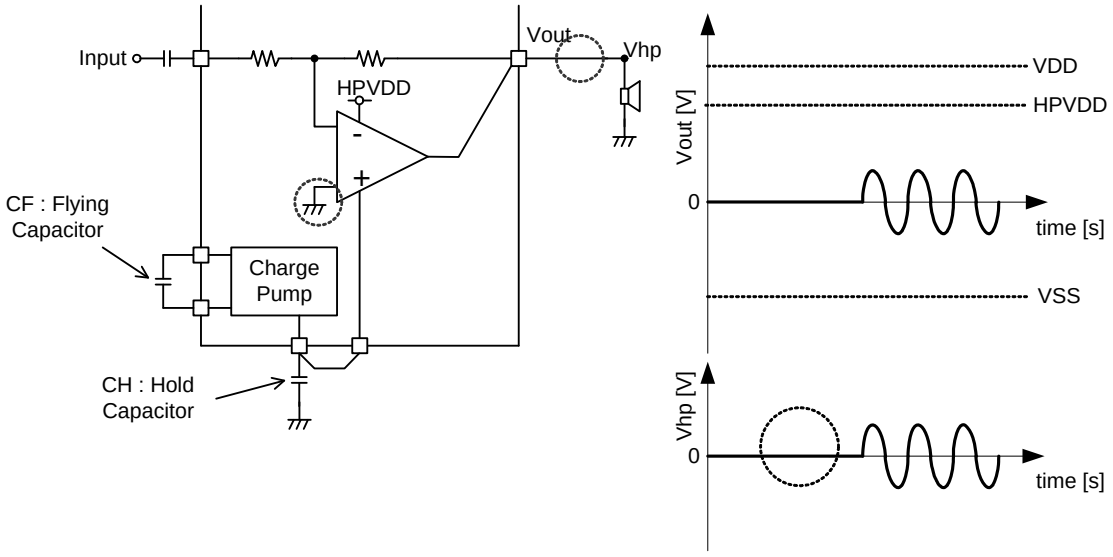


Fig.58 Composition of the series of BD882xxGUL

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BD882☐☐GUL has the function “Virtual Ground-reference output“. “Virtual Ground-reference output” can be canceled Noise (see Fig.59 “Vn”) between IC and headphone jack by feedback ground of headphone jack to IC.

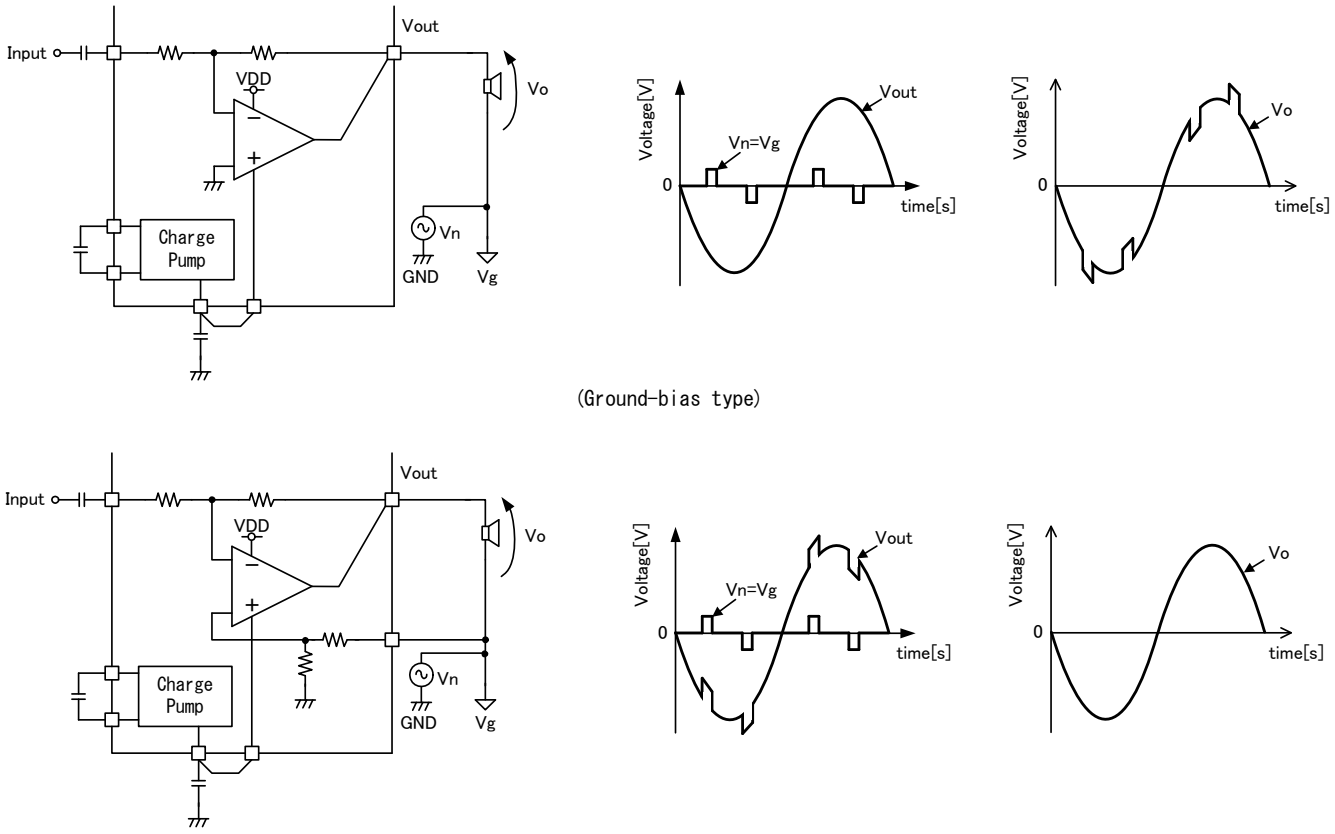


Fig.59. Ground noise canceling function by “virtual ground”

Connect Pin “B2” (COM) to ground near headphone jack.
In case of BD88200GUL, value error of external resistors makes noise rejection characteristic worse.
Put “External resistors” that have high accuracy within 5%, near the LSI.

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[CHARGE PUMP / CHARGE PUMP CONTROL]
The negative power supply circuit is composed of the regulated charge-pump. This circuit outputs the regulated negative voltage (PVSS) directly from power-supply voltage (PVDD). Therefore, it doesn't depend on the power-supply voltage, and a constant voltage is output (PVSS=-2.4V$_{@Typ.}$, refer to Fig.4). Moreover, there is not swinging of the power supply by the output current of the headphone amplifier, and it doesn't influence the headphone amplifier characteristic.

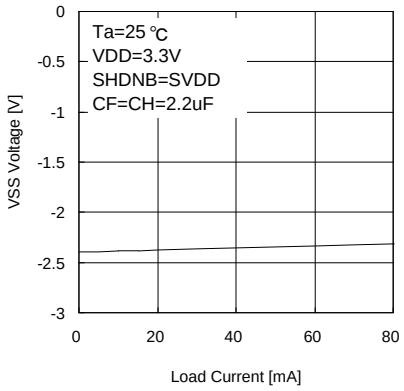


Fig.60 Characteristics of load current regulation of PVSS (Reference data)

・Operating Frequency
The operating frequency of the negative power supply charge pump is designed for the temperature and the voltage dependence may decrease. The reference data (measurements) is occupied to Fig.60. Please note the interference with the frequency in the application board.

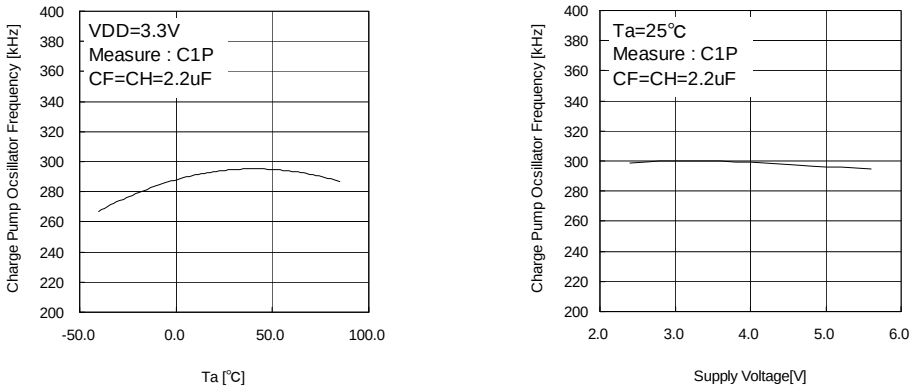


Fig.61 Temperature characteristic and Voltage characteristic of operating frequency (Reference data)

・The flying capacitor and the hold capacitor
The flying capacitor (CF) and the hold capacitor (CH) greatly influence the characteristic of the charge pump. Therefore, please connect the capacitor with an excellent temperature characteristic and voltage characteristic of 2.2µF as much as possible near IC.

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[HEADPHONE AMP]
The headphone amplifier is driven by the internal positive voltage (+2.4V) and negative voltage (SVSS, -2.4V) based on ground (SGND). Therefore, the headphone can be connected without the output coupling capacitor. As a result, it brings the improved low-frequency characteristic compared with the headphone of the conventional coupling capacitor type.

・Power control
When the SVSS voltage is -1.1V$_{@Typ.}$ or more, the headphone amplifier does not operate to protect from illegal operation. And in addition, the overcurrent protection circuit is built in. The amplifier is shutdown when the overcurrent occurs because of the output short-circuit etc., and IC is protected from being destroyed.

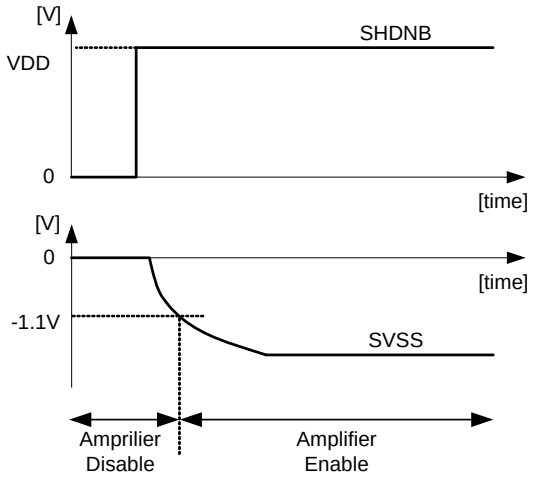


Fig.62 Area of headphone amplifier can operate

SVSS does not have internal connection with PVSS. Please connect SVSS with PVSS on the application board.

・Input coupling capacitor
Input DC level of BD882xxGUL is 0V (SGND). The input coupling capacitor is necessary for the connection with the signal source device. The signal decrease happens in the low frequency because of composing the high-pass filter by this input coupling capacitor and the input impedance of BD882xxGUL.
The input impedance of BD882xxGUL is Rin (14kΩ$_{@Typ.}$). The cutoff frequency of this high-pass filter becomes the following formula. (In BD88200GUL, Rin becomes external resistance Ri.)

$$f_c = \frac{1}{2\pi R_{in} C_{in}} \quad (2)$$

* Cin is the input coupling capacitor.

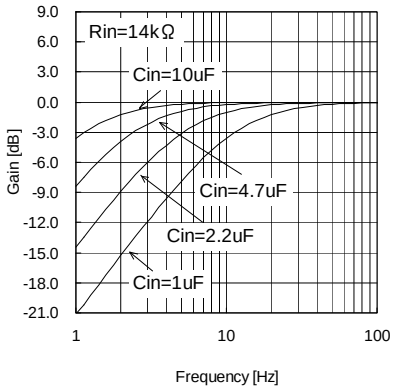
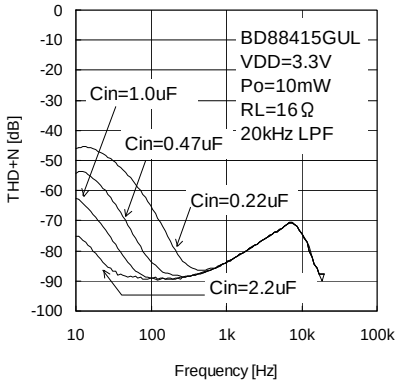


Fig.63 Frequency response by the input coupling capacitor (Reference data)

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And, the degradation of THD+N happens because of the input coupling capacitor. Therefore, please consider these about the selection of parts.



* Capacitor size: 1608

Fig.64 THD+N by the input coupling capacitor (Reference data)

・State of terminal when power down

The state of the terminal changes by the power control of the headphone amplifier. When it is shutdown, the input impedance of the input terminal becomes 7.1kΩ@Typ. (In BD88200GUL, become Ri + 7.1kΩ). The time constant can be reduced when the input coupling capacitor is charged.

The input voltage changes while charging up the input coupling capacitor. Therefore, do not operate the headphone amplifier while charging.

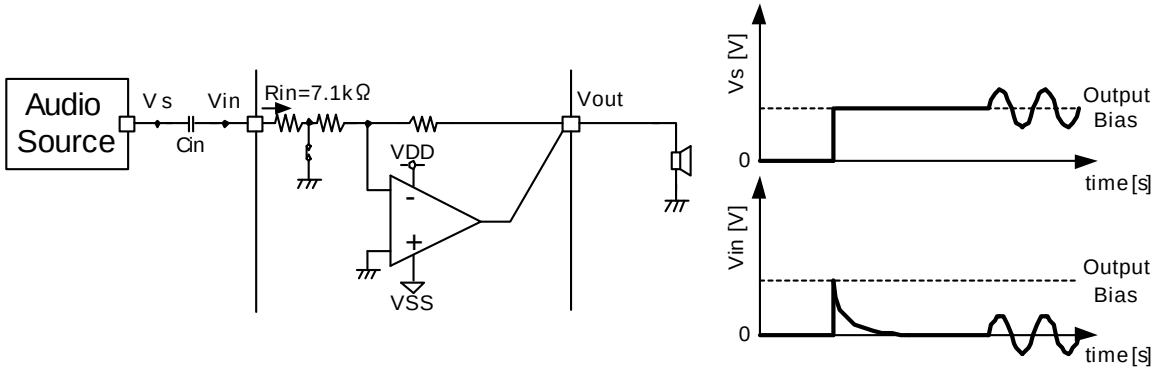


Fig.65 Input voltage transition with input coupling capacitor

This charge time constant becomes the following formula (3) by using the input coupling capacitor and the input impedance. And the calculation value of the convergence to the wait time is indicated in Fig.65.

$$\tau = R_{in}C_{in} \qquad (3)$$

* Rin=7.1kΩ@Typ.. In BD88200GUL, Rin=Ri+7.1kΩ

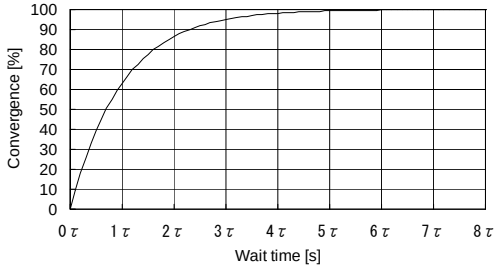


Fig.66 Wait time and convergence (Reference)

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[UVLO / SHUTDOWN CONTROL]
BD882xxGUL has low voltage protection function (UVLO: Under Voltage Lock Out). And protect from the illegal operation of IC by a low power supply voltage.
The detection voltage is $2.13V_{@Typ.}$, so it does not influence 2.4V of recommended operation voltage. UVLO controls the whole of IC, and does both the negative power supply charge pump and the headphone amplifier in power down.

[TSD]
BD882xxGUL has overheating protection function (TSD: Thermal Shutdown). And the headphone amplifier becomes shutdown when illegally overheating by the headphone amplifier illegally operation.

●Timming Chart

(Usually Operation)

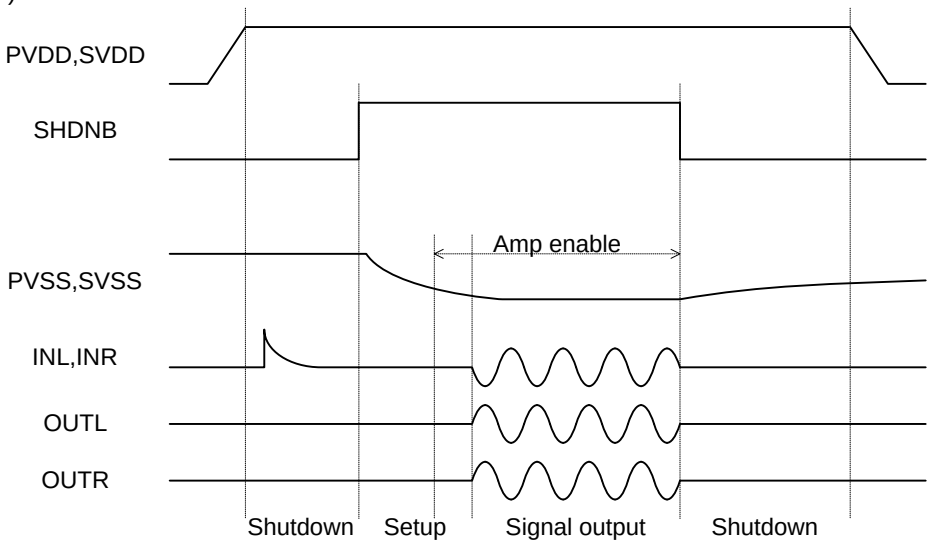


Fig.67 Usually Operation

(UVLO Operation)

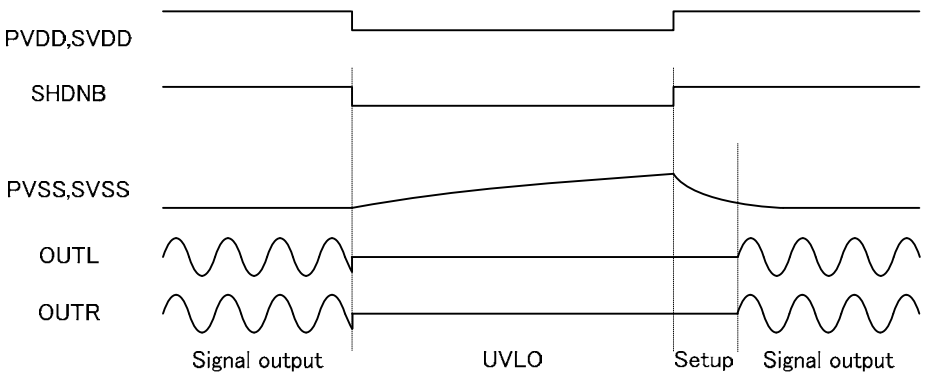


Fig.68 UVLO Operation

(TSD Operation)

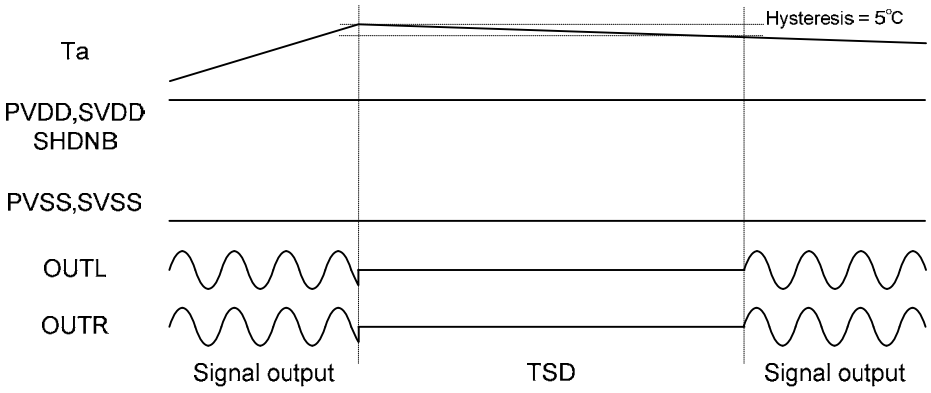
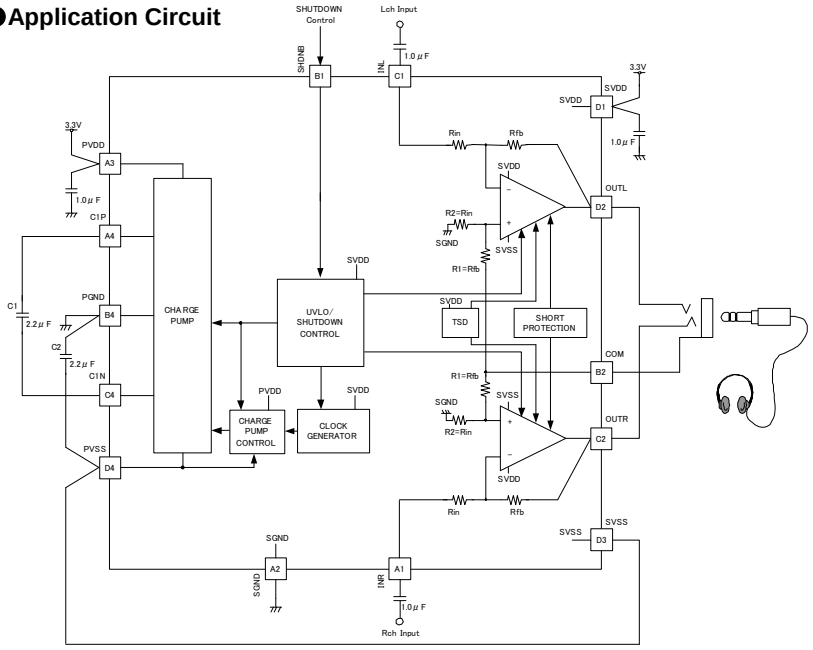


Fig.69 TSD Operation

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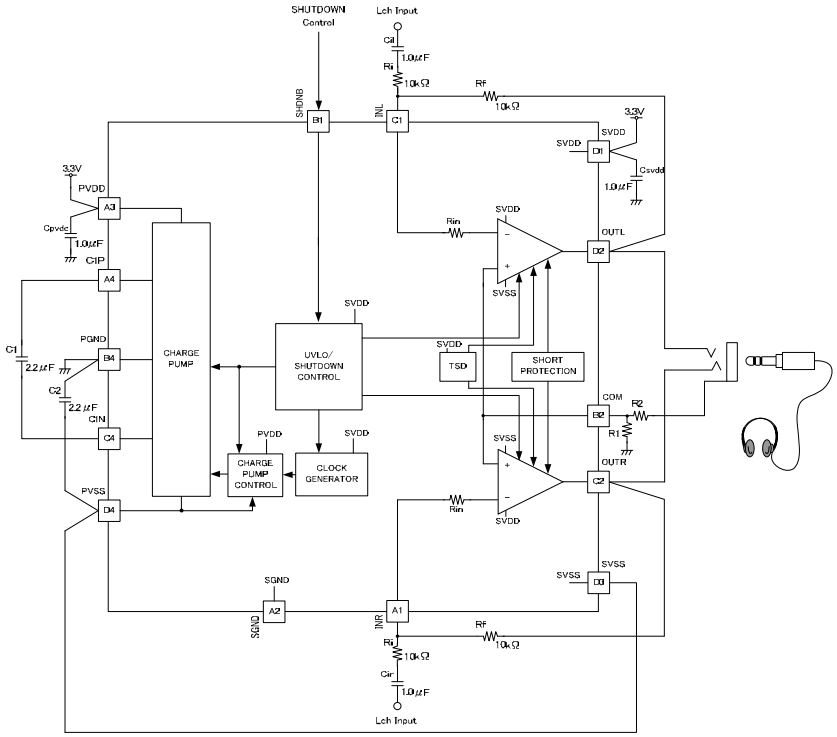
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●Application Circuit



Part	Function	value	Remarks
CF	Flying Capacitor	2.2μF	Temp. Characteristic : Class-B
CH	Hold Capacitor	2.2μF	Temp. Characteristic : Class-B
Cpvdd	Bypass Capacitor	1.0μF	Temp. Characteristic : Class-B
Csvdd	Bypass Capacitor	1.0μF	Temp. Characteristic : Class-B
Cil	Coupling Capacitor	1.0μF	Temp. Characteristic : Class-B
Cir	Coupling Capacitor	1.0μF	Temp. Characteristic : Class-B

Fig.70 BD88210GU/BD88215GUL/BD88220GUL application circuit



Part	Function	value	Remarks
CF	Flying Capacitor	2.2μF	Temp. Characteristic : Class-B
CH	Hold Capacitor	2.2μF	Temp. Characteristic : Class-B
Cpvdd	Bypass Capacitor	1.0μF	Temp. Characteristic : Class-B
Csvdd	Bypass Capacitor	1.0μF	Temp. Characteristic : Class-B
Cil	Coupling Capacitor	1.0μF	Temp. Characteristic : Class-B
Cir	Coupling Capacitor	1.0μF	Temp. Characteristic : Class-B
Ri	Input Resistor	10kΩ	MCR006YZPJ103 (ROHM)
Rf	Feedback Resistor	10kΩ	MCR006YZPJ103 (ROHM)

Fig.71 BD88200GUL application circuit

In BD88200GUL, the Pass Gain becomes the following formula (4). The Pass Gain and the resister Rf is limited by table.3.

$$\text{Gain} = \frac{R_f}{R_i} \quad (4)$$

Table.3 Pass Gain and Resister Limit

Item	Min.	Typ.	Max.	Unit
Pass Gain	0.5	1.0	2.0	V/V
Rf	1.0	10	-	kΩ
Ri	-	10	-	kΩ

Ri is not limited. But, if this resister Ri is very small, the signal decrease happens in the low frequency (Refer to formula 2).

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●Thermal Derating Curve

The reference value of the thermal derating curve is indicated in Fig.71.

(Conditions)
This value is for mounted on the ROHM application board
Board size：40mm x 60mm x 1.6mm
Top Copper Area：79.9%
Bottom Copper Area：80.2%
Board Layout：Fig.74

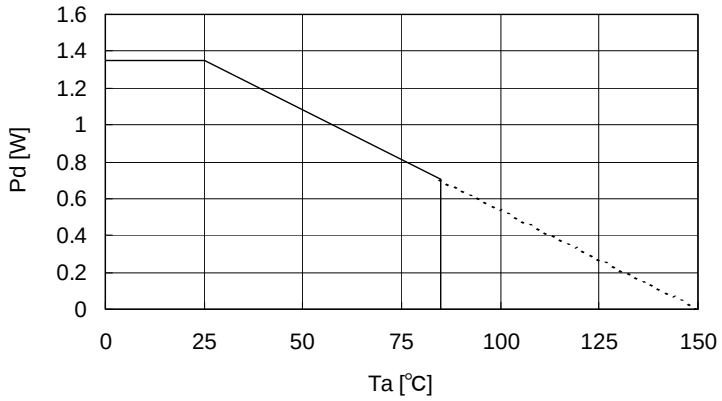


Fig.72 Thermal Derating Curve

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●Notes for use

(1) Absolute Maximum Ratings
An excess in the absolute maximum ratings, such as supply voltage, temperature range of operating conditions, etc., can break down devices, thus making impossible to identify breaking mode such as a short circuit or an open circuit. If any special mode exceeding the absolute maximum ratings is assumed, consideration should be given to take physical safety measures including the use of fuses, etc.

(2) Operating conditions
These conditions represent a range within which characteristics can be provided approximately as expected. The electrical characteristics are guaranteed under the conditions of each parameter.

(3) Reverse connection of power supply connector
The reverse connection of power supply connector can break down ICs. Take protective measures against the breakdown due to the reverse connection, such as mounting an external diode between the power supply and the IC's power supply terminal.

(4) Power supply line
Design PCB pattern to provide low impedance for the wiring between the power supply and the GND lines. In this regard, for the digital block power supply and the analog block power supply, even though these power supplies has the same level of potential, separate the power supply pattern for the digital block from that for the analog block, thus suppressing the diffraction of digital noises to the analog block power supply resulting from impedance common to the wiring patterns. For the GND line, give consideration to design the patterns in a similar manner.
Furthermore, for all power supply terminals to ICs, mount a capacitor between the power supply and the GND terminal. At the same time, in order to use an electrolytic capacitor, thoroughly check to be sure the characteristics of the capacitor to be used present no problem including the occurrence of capacity dropout at a low temperature, thus determining the constant.

(5) GND voltage
Make setting of the potential of the GND terminal so that it will be maintained at the minimum in any operating state. Furthermore, check to be sure no terminals are at a potential lower than the GND voltage including an actual electric transient.

(6) Short circuit between terminals and erroneous mounting
In order to mount ICs on a set PCB, pay thorough attention to the direction and offset of the ICs. Erroneous mounting can break down the ICs. Furthermore, if a short circuit occurs due to foreign matters entering between terminals or between the terminal and the power supply or the GND terminal, the ICs can break down.

(7) Operation in strong electromagnetic field
Be noted that using ICs in the strong electromagnetic field can malfunction them.

(8) Inspection with set PCB
On the inspection with the set PCB, if a capacitor is connected to a low-impedance IC terminal, the IC can suffer stress. Therefore, be sure to discharge from the set PCB by each process. Furthermore, in order to mount or dismount the set PCB to/from the jig for the inspection process, be sure to turn OFF the power supply and then mount the set PCB to the jig. After the completion of the inspection, be sure to turn OFF the power supply and then dismount it from the jig. In addition, for protection against static electricity, establish a ground for the assembly process and pay thorough attention to the transportation and the storage of the set PCB.

(9) Input terminals
In terms of the construction of IC, parasitic elements are inevitably formed in relation to potential. The operation of the parasitic element can cause interference with circuit operation, thus resulting in a malfunction and then breakdown of the input terminal. Therefore, pay thorough attention not to handle the input terminals, such as to apply to the input terminals a voltage lower than the GND respectively, so that any parasitic element will operate. Furthermore, do not apply a voltage to the input terminals when no power supply voltage is applied to the IC. In addition, even if the power supply voltage is applied, apply to the input terminals a voltage lower than the power supply voltage or within the guaranteed value of electrical characteristics.

(10) Ground wiring pattern
If small-signal GND and large-current GND are provided, It will be recommended to separate the large-current GND pattern from the small-signal GND pattern and establish a single ground at the reference point of the set PCB so that resistance to the wiring pattern and voltage fluctuations due to a large current will cause no fluctuations in voltages of the small-signal GND. Pay attention not to cause fluctuations in the GND wiring pattern of external parts as well.

(11) External capacitor
In order to use a ceramic capacitor as the external capacitor, determine the constant with consideration given to a degradation in the nominal capacitance due to DC bias and changes in the capacitance due to temperature, etc.

(12) About the rush current
For ICs with more than one power supply, it is possible that rush current may flow instantaneously due to the internal powering sequence and delays. Therefore, give special consideration to power coupling capacitance, power wiring, width of GND wiring, and routing of wiring.

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●Ordering part number

B	D	8	8	2	1	5	G	U	L	-	E	2

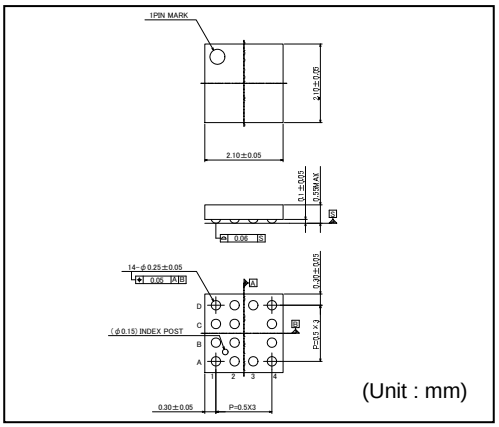
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Part No.
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BD88215
BD88220

Package
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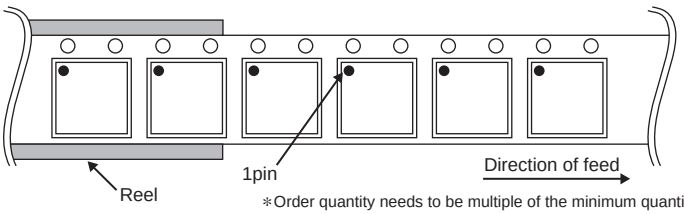
Packaging and formingspecification
E2: Embossed tape and reel

VCSP50L2(BD882xxGUL)



<Tape and Reel information>

Tape	Embossed carrier tape
Quantity	3000pcs
Direction of feed	E2 (The direction is the 1pin of product is at the upper left when you hold reel on the left hand and you pull out the tape on the right hand)



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

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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:
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   [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

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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.

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