ROHM SEMICONDUCTOR

Technical Note

Class-AB Speaker Amplifiers

1.1W to1.5W Monaural Speaker Amplifier

BD7830NUV

No.10077EAT03

●Description

The BD7830NUV is a monaural speaker amplifier that operates at low voltage and was developed for portable navigation and mobile audio products. When in standby mode, its current consumption is 0 μA, and since it switches quickly and quietly from standby to ON, it is especially well suited for applications where there is frequent switching between standby and ON.

●Features

1) BTL monaural audio power amplifier
2) High power 2.25W 4Ωat Vcc=5V ,THD+N=10%
   High power 1.55W 8Ω at Vcc=5V ,THD+N=10%
   High power 0.77W 8Ω at Vcc=3.6V ,THD+N=10%
3) Wide operating supply voltage range: 2.4～5.5V
4) Low standby current: 0μA
5) Fast turn on/off time: 46msec
6) Built-in Fade-in/out function
7) Built-in anti-pop function
8) Built-in thermal shutdown function
9) Very small package (VSON008V2030)

●Applications

Mobile phones, Mobile electronics applications

●Absolute Maximum Ratings(Ta=+25℃)

Parameter	Symbol	Ratings	Unit
Supply voltage	Vcc	6.0	V
Power dissipation	Pd	530 *1	mW
Storage temperature range	Tstg	-55～+150	℃
STBY input range	Vstby	-0.1～Vcc+0.1	V

*1 ROHM standard one layer board (70mm×70mm×1.6mmt) mounted, deratings is done at 4.24mW/℃ above Ta=+25℃.

●Operating Range

Parameter	Symbol	Ratings	Unit
Temperature range	Topr	-40～+85	℃
Supply voltage	Vcc	+2.4～+5.5	V

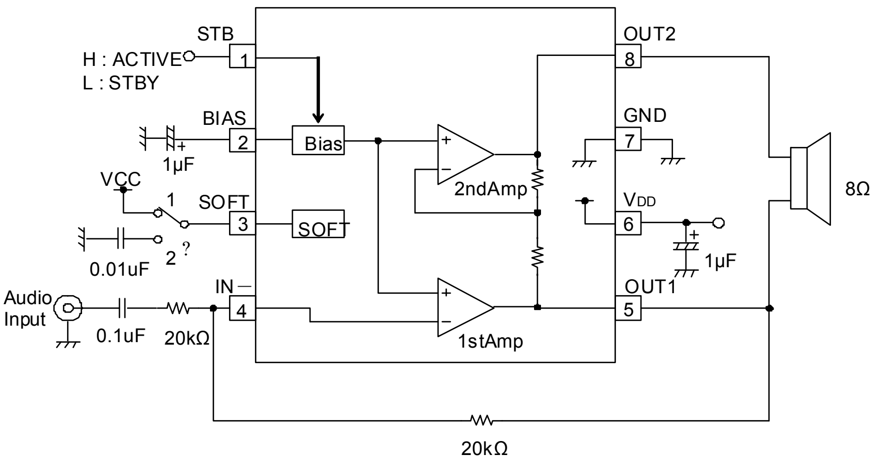
※ This product is not designed for protection against radioactive rays.

●Electrical characteristics (Unless otherwise noted, Ta=+25℃, Vcc=+3.0V, f=1kHz, RL=8Ω)

Parameter	Symbol	Limit MIN.	Limit TYP.	Limit MAX.	Unit	Monitor pin	Condition
Supply current	I_{CC}	—	3.2	6.8	mA	6	Active mode
Standby supply current	I_{STBY}	—	0	2	μA	6	Standby mode
Output power	P_O	280	420	—	mW	5&8	BTL, THD+N=1% *1
Total harmonic distortion	T_{HD}+N	—	0.1	0.5	%	5&8	BTL, Po=150mW *1
Voltage gain1	A_{V1}	-1	0	+1	dB	5	Vin=-20dBV, 1stAmp
Voltage gain2	A_{V2}	-1	0	+1	dB	8	Vin=-20dBV, 2ndAmp
Power supply rejection ratio	P_{SRR}	40	57	—	dB	5&8	BTL, Vripple=0.2Vpp, *2
Mute attenuation	M_{UTE}	60	80	—	dB	5&8	BTL, Vin=-20dBV
Output voltage	Vo	1.35	1.5	1.65	V	5&8	Vin=0V
Output offset voltage	ΔVo	-40	0	+40	mV	5&8	ΔVo=|Vo1-Vo2|
STBY release voltage	V_{STBYH}	1.4	—	Vcc+0.1	V	1	Active mode
STBY hold voltage	V_{STBYL}	-0.1	—	0.4	V	1	Standby mode
STBY input current H	I_{STBYH}	20	30	40	μA	1	V_{STBY} =3V
STBY input current L	I_{STBYL}	-2	0	—	μA	1	V_{STBY} =0V

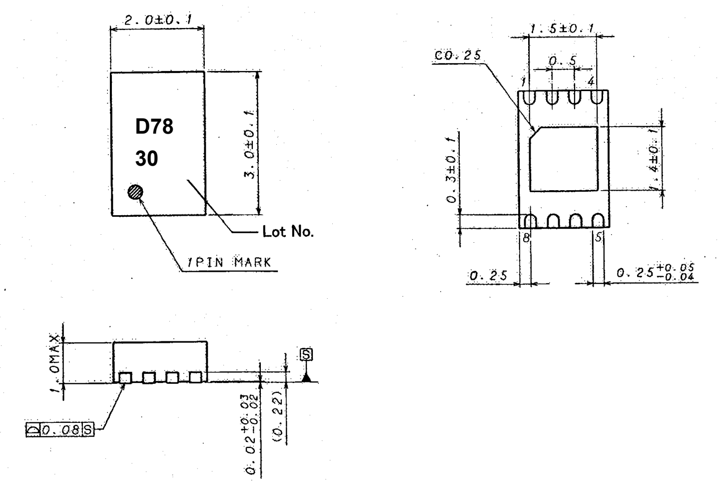
*1:B.W.=400～30kHz, *2:DIN AUDIO, SE:Single End, BTL:The voltage between 5pin and 8pin

●Application Circuit Example

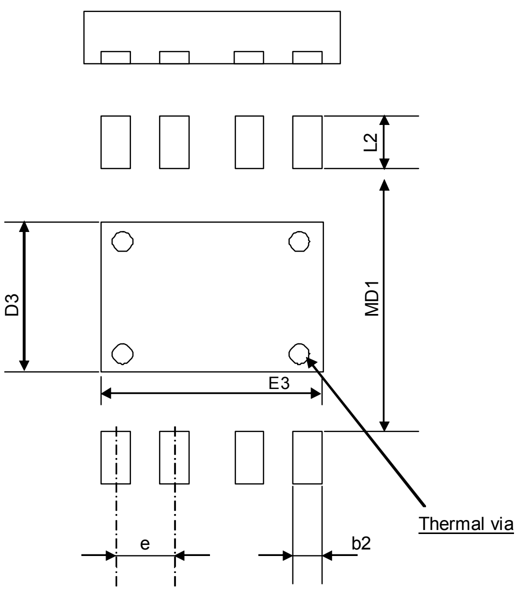


※3pin SOFT terminal
1 : Usually
2 : Enable to adjust fade in/out time by external capacitor

● **Outer dimension**



● **Reference land pattern** (adapt as necessary to suit conditions during actual design.)



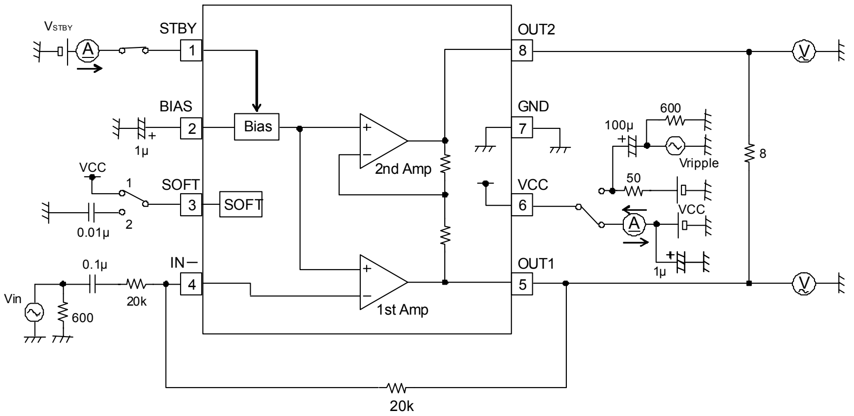
Unit: mm

PKG type	Lead pitch	Land		
		Gap	Length	Width
	e	MD1	L2	b2
VSON008V2030	0.50	2.20	0.70	0.27

PKG type	Central pad		Thermal via	
	Length	Width	Pitch	Diameter
	D3	E3		
VSON008V2030	1.20	1.60	—	ϕ0.300

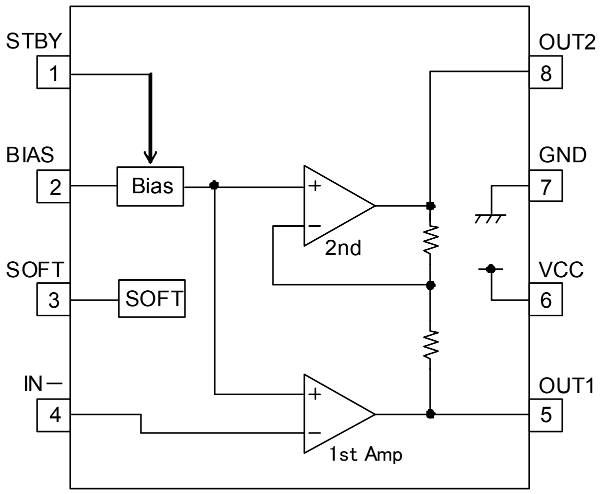
※ This package is a non-lead type, so solderability of the lead ends and sides are not guaranteed.

●Measurement Circuit Diagram



※3pin SOFT terminal
1 : Usually
2 : Enable to adjust fade in/out time by external capacitor

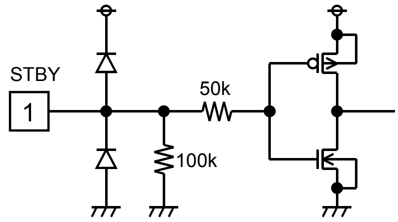
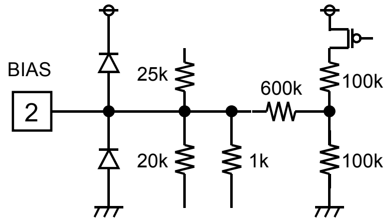
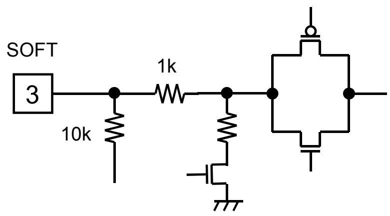
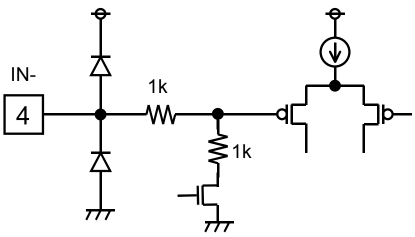
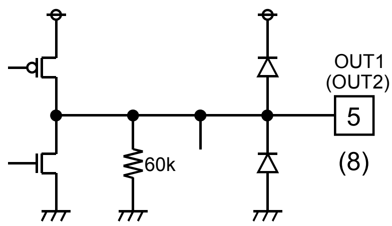
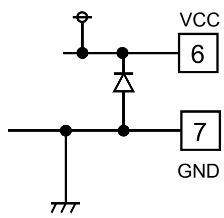
●Block diagram



●Pin assignment

PIN No.	PIN Name
1	STBY
2	BIAS
3	SOFT
4	IN-
5	OUT1
6	VCC
7	GND
8	OUT2

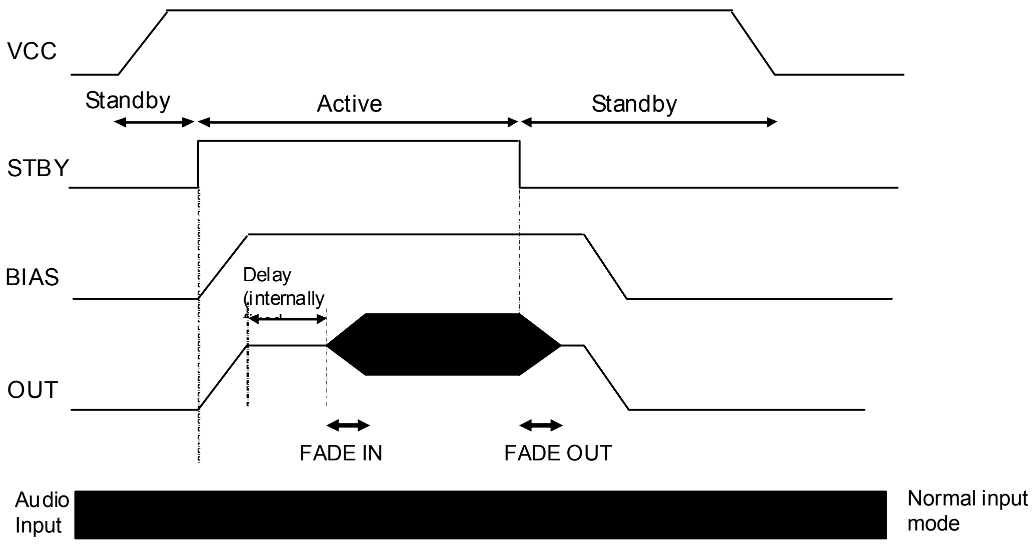
●Input/output equivalent circuit

PIN No.	PIN Name	PIN description	Equivalent circuit
1	STBY	Active/Standby Control pin STBY=H → Active STBY=L → Standby	
2	BIAS	Bias capacitor Connection pin	
3	SOFT	Fade-in/out Adjustment pin	
4	IN-	Input pin	
5 8	OUT1 OUT2	Output pin	
6	VCC	Power supply pin	
7	GND	GND pin	

Notes) The above numerical values are typical values for the design, which are not guaranteed.

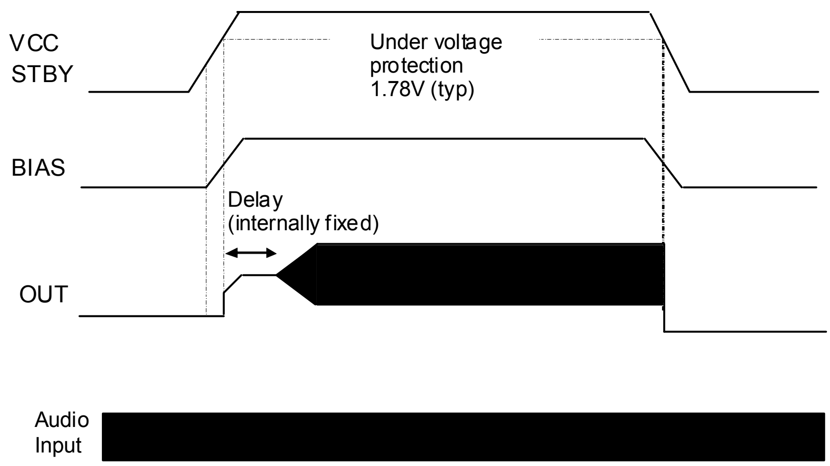
●Description of operations

①ON/OFF operation by STBY pin



Once VCC = H, when STBY = L → H then BIAS and output (OUT) are activated.
Once BIAS has become stable (= 1/2 VCC), output (OUT) fades in (FADE IN).
Once STBY = H → L, output (OUT) starts to fade out (FADE OUT), and when fade-out ends, the BIAS falls.

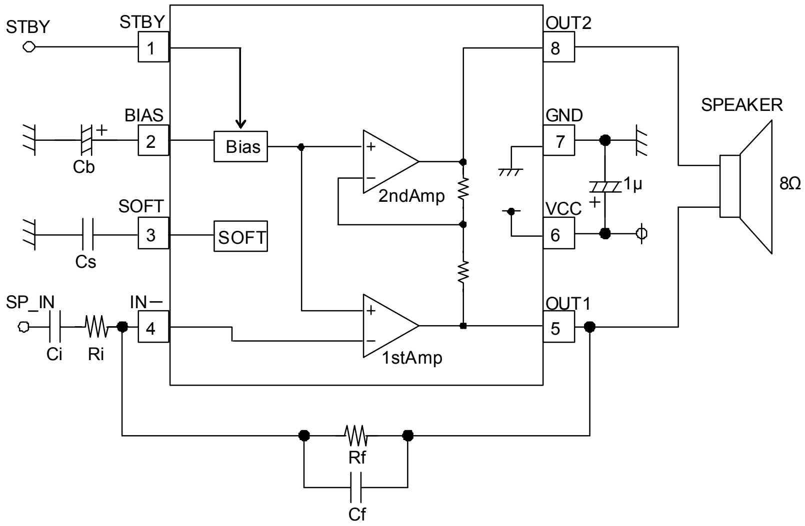
②ON/OFF control by shorting of VCC and STBY pins



When VCC = STBY = L → H, BIAS is activated. During low power mode (VCC < 1.78 V) protection is used to keep output (OUT) at low level, and FADE IN occurs when this protection is canceled. When VCC = STBY = H → L, output (OUT) falls without FADE OUT.

●External components and cautions points

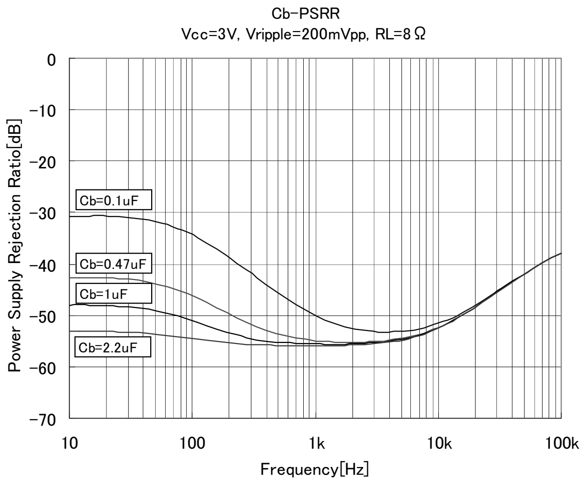
Setting of external components



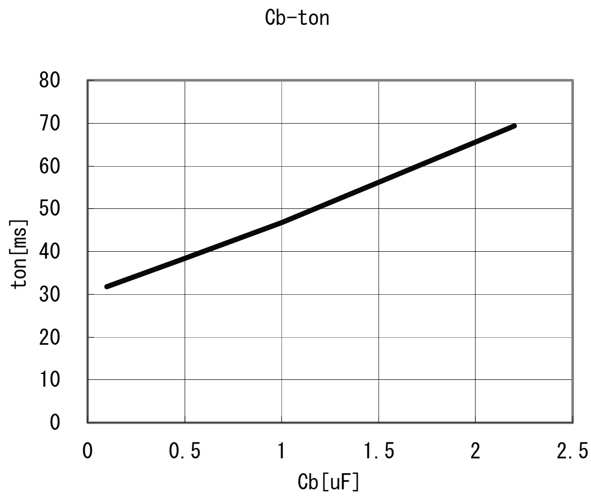
●Cb

This is a bypass capacitor, which is used for bias voltage stabilization.
When a larger capacitor is used, the efficiency of voltage ripple rejection can be improved.
When tuning, note with caution that Cb can affect the activation time.

Cb – Power Supply Ripple Rejection Ratio



Cb – Turn-on Time

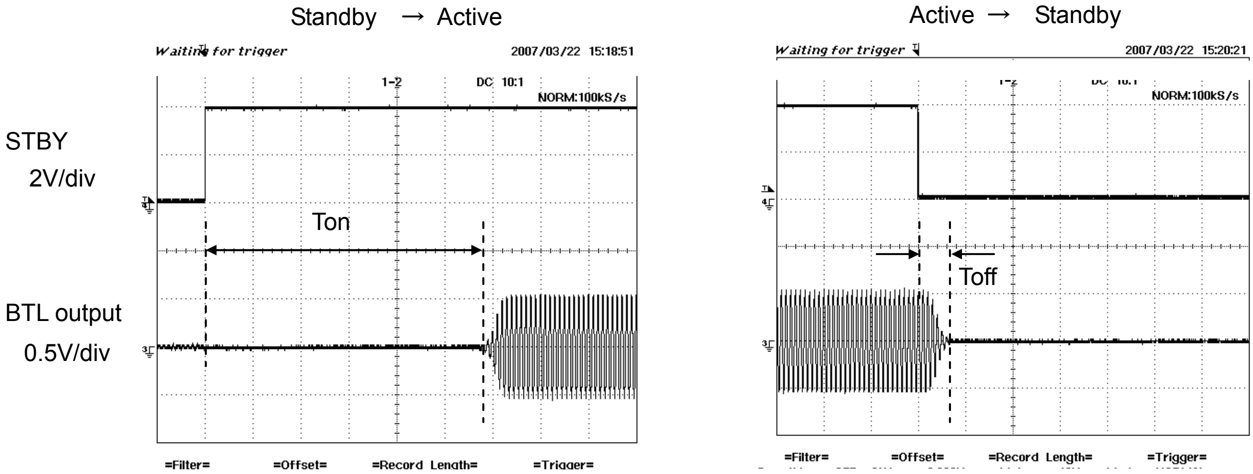


●Cs

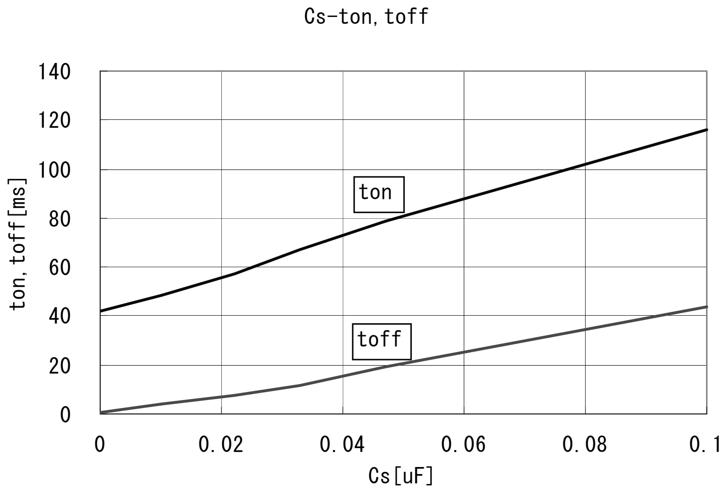
This capacitor is for adjustment of the FADE IN/OUT times. The FADE IN/OUT functions soften the operation (IN and OUT) of BTL output when switching between standby and active modes.

When a capacitor is connected to the SOFT pin (pin 3), the FADE IN/OUT functions are valid. When the capacitor rating is increased, the FADE IN/OUT effect is also increased, but note with caution when setting this that it also affects the activation time. If the FADE IN/OUT functions are not being used, connect the SOFT pin (pin 3) to VCC.

・ Fade-in/out waveforms



Cs - Fade-in/out Time

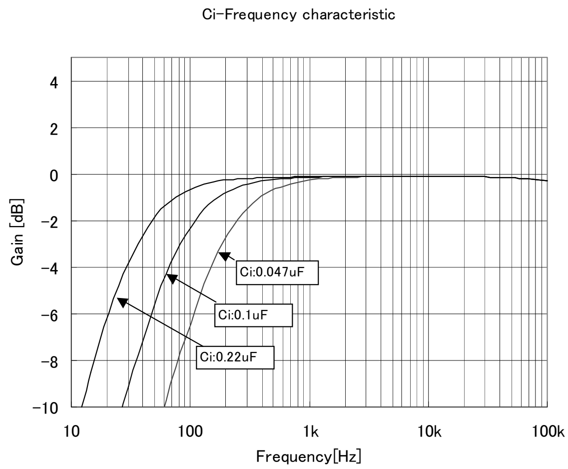


●**Ci**

This is a DC cut-off input coupling capacitor for the amp input pin.
This includes an Ri and a high-pass filter. The cut-off frequency is calculated as follows.

$$f_{CL} = \frac{1}{2\pi \times Ri \times Ci} \quad [Hz]$$

Ci – Low Frequency Characteristics



Capacitors of a certain size are required for coupling without attenuation of low frequencies, but in most cases of speakers used in portable equipment, it is nearly impossible to reproduce signals in the 100 to 200 Hz range or below. Even when a larger capacitor is used instead, it may not improve system performance. Also, pop sounds can affect the capacitance (Ci) of the capacitor. A larger coupling capacitor requires a greater charge to reach the bias DC voltage (normally 1/2 VCC). Because this charge current is supplied from the output due to routing of feedback, pop sounds occur easily at startup. Consequently, pop sounds can be minimized by selecting the smallest capacitor that still has the required low-frequency response.

●**Ri**

This is inverting input resistance, which sets the closed loop gain in conjunction with Rf.

●**Rf**

This is feedback resistance, which sets closed loop gain in conjunction with Rf. The amp gain is set using the following formula.

$$Gain = 20\log\left(\frac{Rf}{Ri}\right) \quad [dB]$$

●**Cf**

This is a feedback capacitor, which is used to cut high frequencies.
This includes Rf and a low-pass filter. The cut-off frequency is calculated as follows.

$$f_{CL} = \frac{1}{2\pi \times Ri \times Ci} \quad [Hz]$$

●Selection of external components

①Setting gain from desired output
Output Po is determined via the following formula, from which the required gain Av can also be obtained.

$Po\ [W] = Vo^2\ [Vrms] / RL\ [\Omega]$

$Vo = Av \cdot Vin$

$Av \geqq \sqrt{Po \cdot RL} / Vin$

②Setting input resistance and feedback resistance from gain
Gain Av is determined via the following formula, from which input resistance Rin and feedback resistance Rf can be set.

$Av = (Rf / Rin) \cdot 2$

Rin is set with the input side's drive capacity taken into account.

③Setting input coupling capacitor from low-range cut-off frequency
Low-range cut-off frequency fc is determined via the following formula, from which input coupling capacitor Cin can be set.

$fc\ [Hz] = 1 / (2\pi \cdot Rin \cdot Cin)$

$Cin \geqq 1 / (2\pi \cdot Rin \cdot fc)$

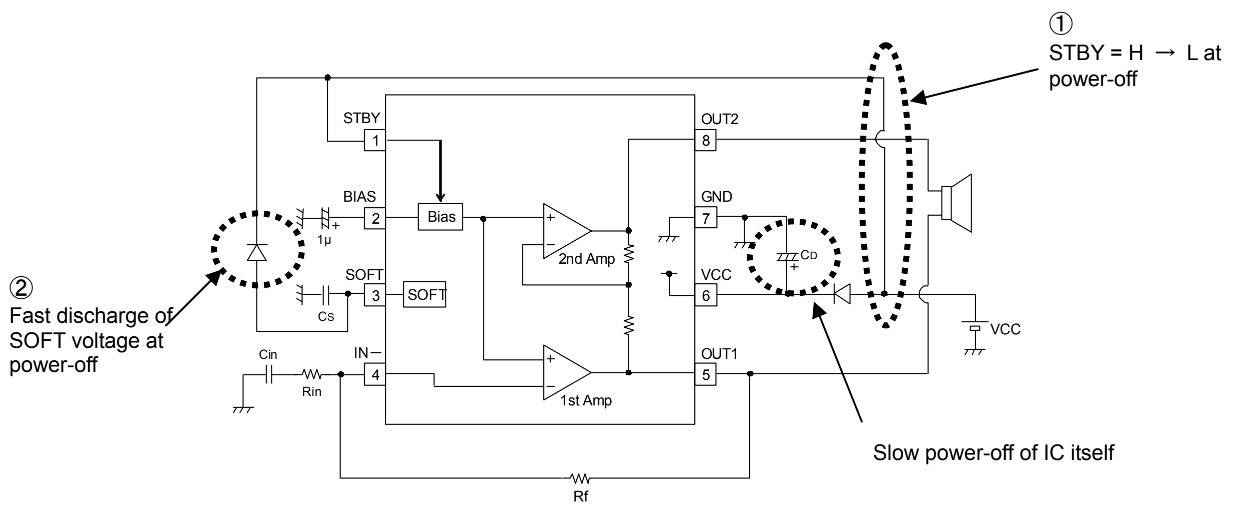
④Setting bias capacitor and SOFT capacitor to minimize pops
It is recommended that the capacitance of the bias capacitor CB be set to at least 10 times that of the input coupling capacitor Cin, in order to soften the rise of the bias voltage while improving the Cin following ability.
Also, when a higher gain is used, the capacitance of the SOFT capacitor Cs can be raised to control pop sounds.

Av = 2 (6 dB at BTL) → $Cs \cdot (80 / fc) \geqq 0.01\ \mu F$
Av = 4 (12 dB at BTL) → $Cs \cdot (80 / fc) \geqq 0.022\ \mu F$
Av = 8 (18 dB at BTL) → $Cs \cdot (80 / fc) \geqq 0.033\ \mu F$
Av = 20 (26 dB at BTL) → $Cs \cdot (80 / fc) \geqq 0.068\ \mu F$

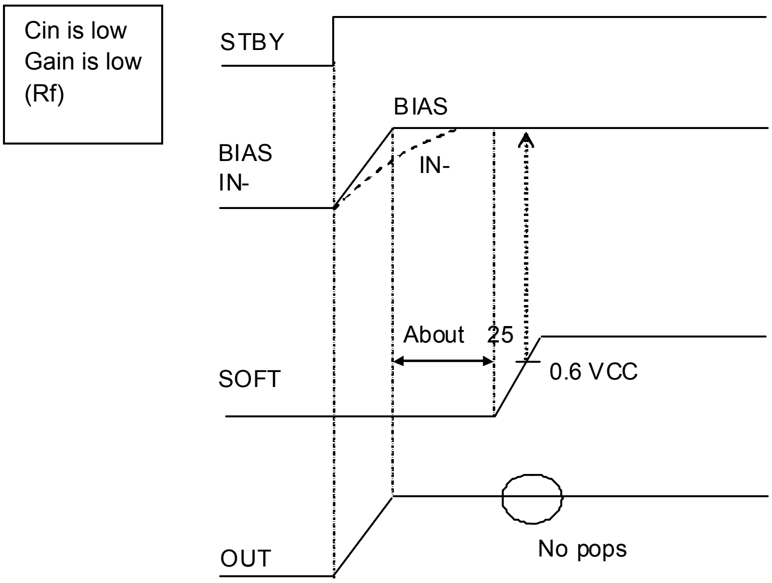
●Use when VCC = STBY short

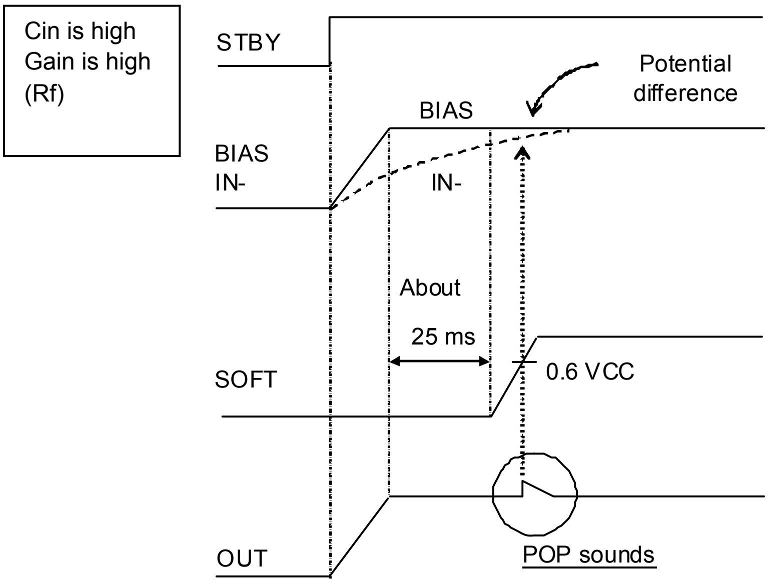
Since this IC is designed on the assumption that it will be used to switch standby mode ON and OFF while the power supply remains ON, normally STBY should be switched from H to L and the SOFT voltage should be discharged before powering down. When used while VCC = STBY short, pop sounds may occur if the IC's power supply is reduced prior to discharging the SOFT voltage.
To prevent pop sounds, you must ① set STBY = H→L before setting VCC = H→L, and ② forcibly discharge the SOFT voltage.
A sample circuit in which VCC = STBY short is used is shown below.

・Sample circuit configuration when VCC = STBY short



●**Mechanism of pop sounds**

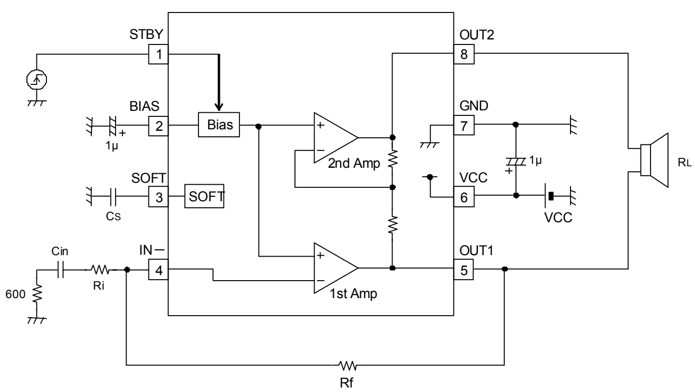




When SOFT voltage reaches 0.6 VCC, if there is a potential difference between BIAS and IN-, pop sounds will occur.

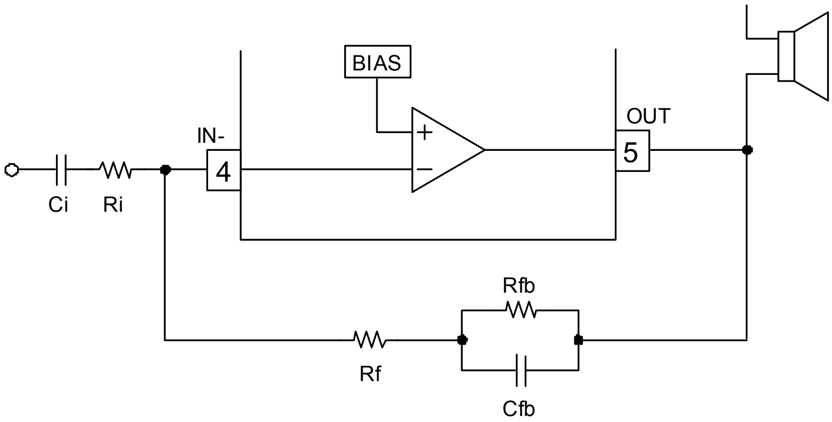
At startup, the input coupling Cin is charged from output OUT via the feedback resistance Rf, so when
Cin and Rf are high, charging takes longer and pop sounds can easily occur.

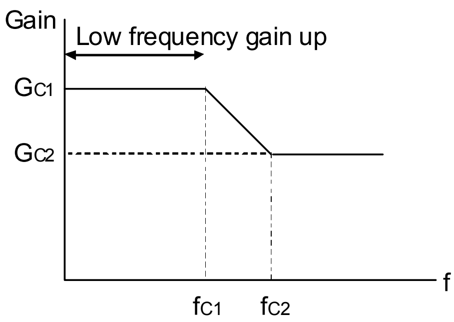
The rise of the SOFT voltage is changed by Cs, so pop sounds an be reduced by setting Cs high.



●Bass boost function

External components can be added to this chip to provide a bass boost function.





$$f_{C2} = \frac{1}{2\pi * Cfb * Rf} \quad [Hz]$$

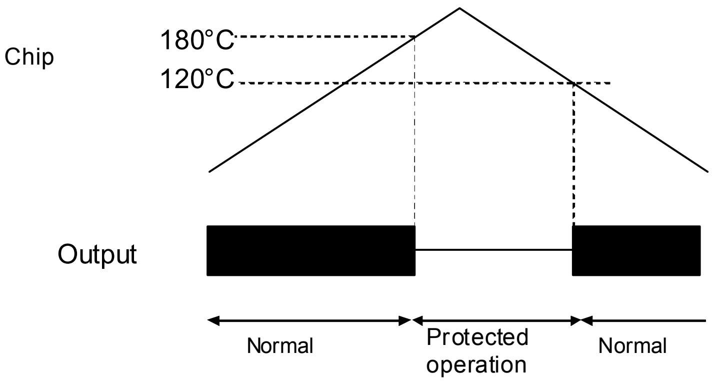
$$f_{C1} = \frac{1}{2\pi * Cfb * (Rf // Rfb)} \quad [Hz]$$

$$G_{C1} = 20\log\frac{Rf + Rfb}{Ri} \quad [dB]$$

$$G_{C2} = 20\log\frac{Rf}{Ri} \text{ (normal use)} \quad [dB]$$

●Thermal shutdown function

When the chip exceeds the Tjmax (150°C) temperature by reaching a temperature of 180℃ or above, the protection function is activated. High impedance is for OUT1 and OUT2 during protected mode. Protection is canceled and normal operation is resumed when the chip's temperature falls to 120℃ or below.



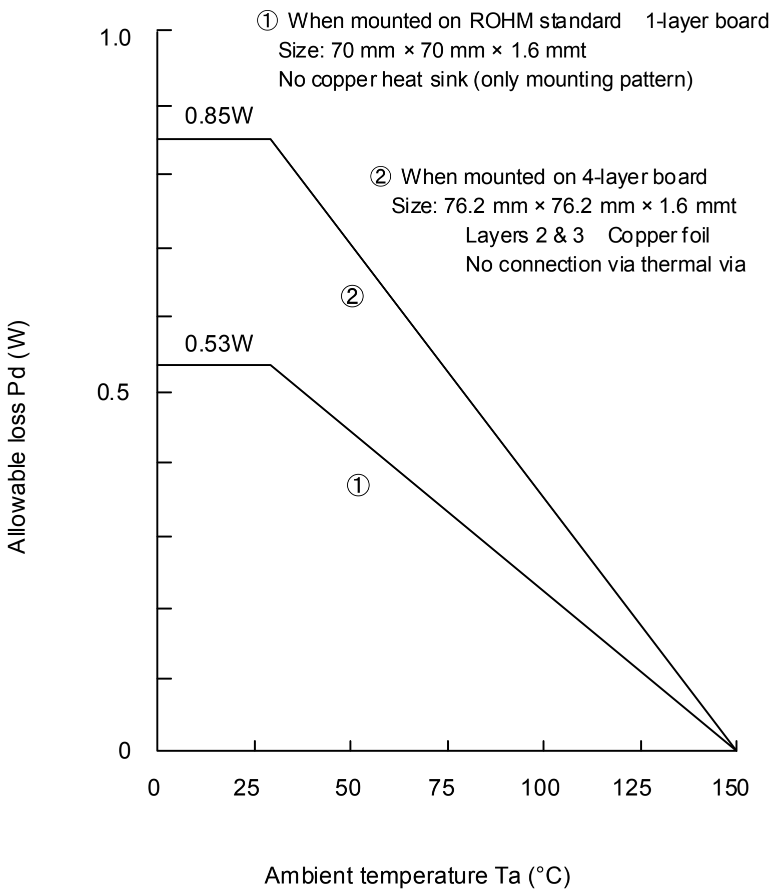
Protection start temperature: 180°C (typ) or more
Protection cancels temperature: 120°C (typ) or less

●Thermal design of chip

The characteristics of the IC vary greatly depending on the use temperature, and when the maximum allowable junction temperature is exceeded, components may deteriorate or become damaged. Thermal considerations are needed for this chip from two standpoints: preventing instantaneous damage and improving long-term reliability. Note the following points with caution.
The absolute maximum ratings for each chip include the maximum junction temperature (Tj_{MAX}) and operating temperature rate (Topr), and these values should be referred to when using the Pd-Ta characteristics (thermal dissipation curve).
Since the IC itself is designed with full consideration of thermal balance, there are no problems in terms of circuit operations, but even when a more-than-adequate thermal design is implemented in order to get full use of the IC's performance features, some moderation is often required for the sake of practical usage.
If there is an excessive input signal due to insufficient thermal dissipation, a TSD (thermal shutdown) operation may occur.

Thermal Dissipation Curve

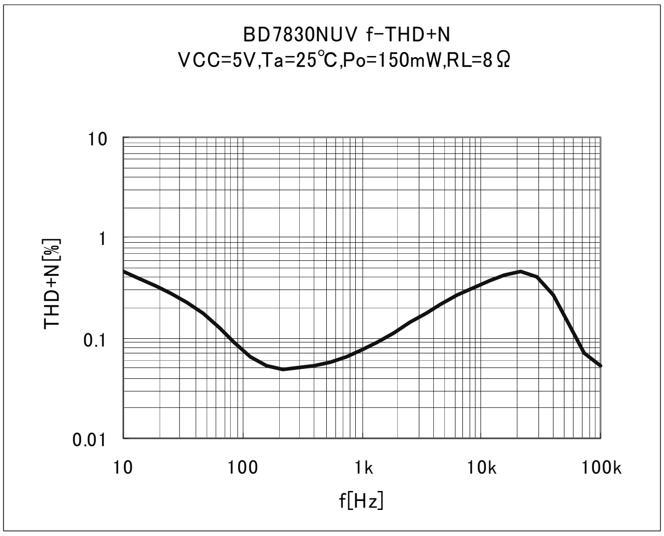
Reference data **VSON008V2030**

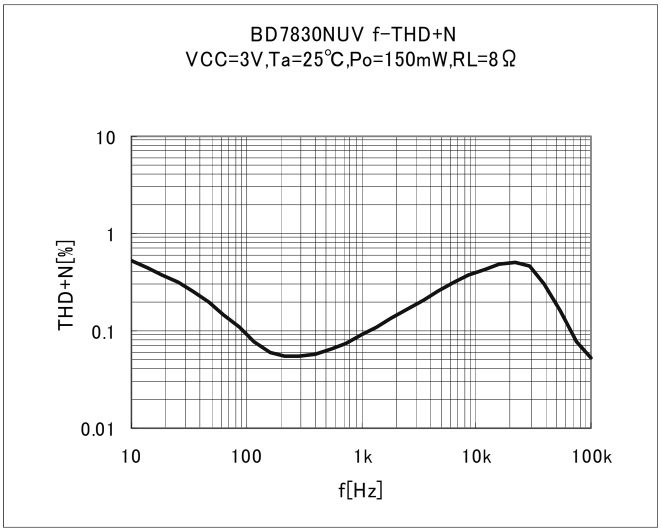


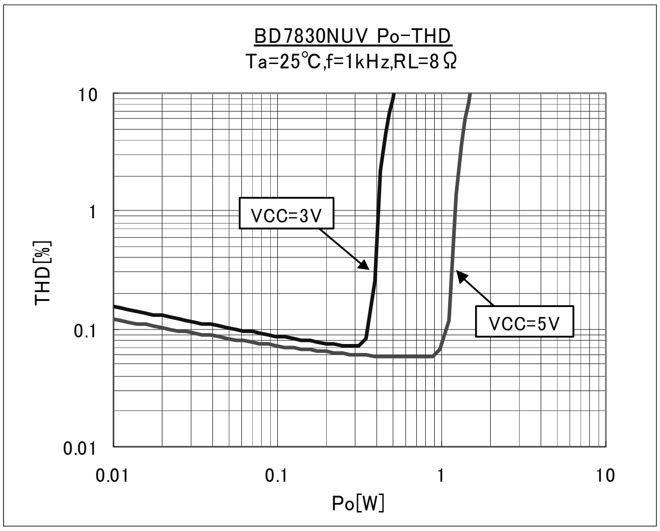
(Note) These are measured values. They are not guaranteed.

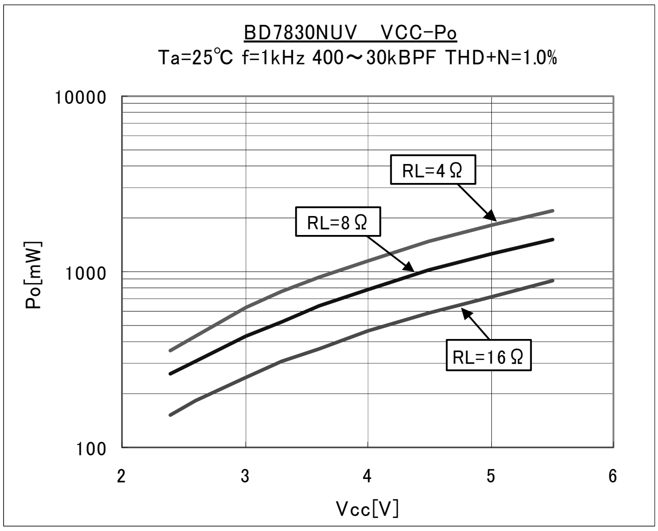
The allowable loss value varies depending on the type of board used for mounting. When this chip is mounted on a multi-layer board that is designed for thermal dissipation, the allowable loss becomes greater than shown in the above figure.

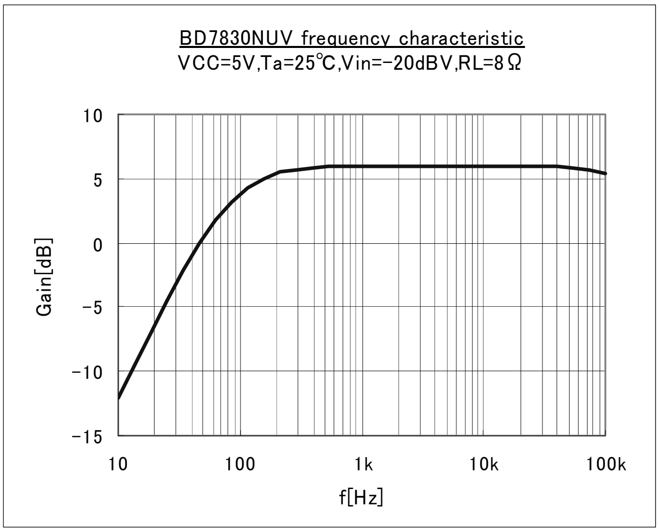
●Typical Characteristics (1)

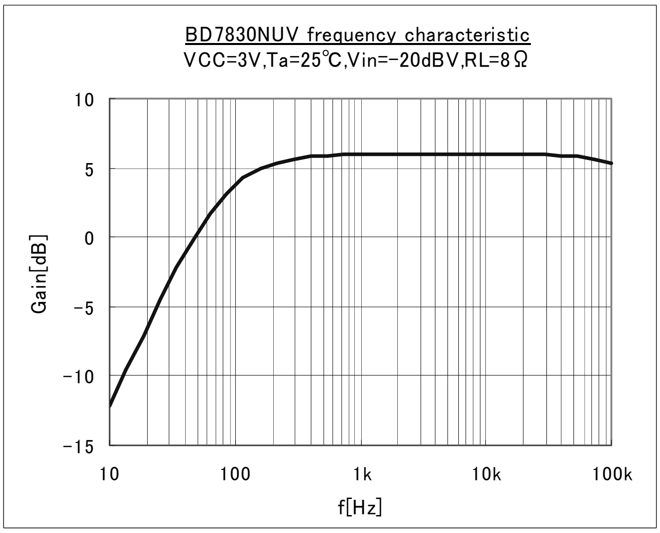




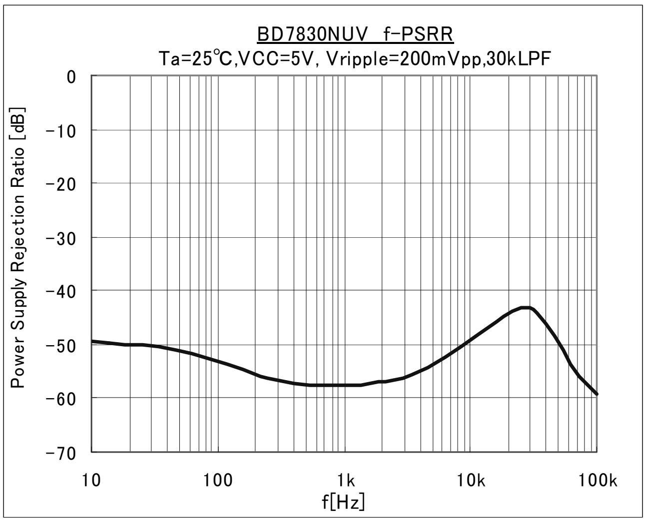


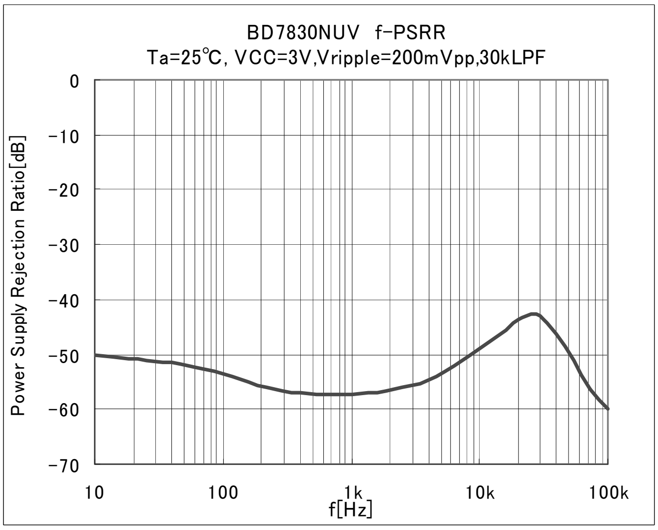


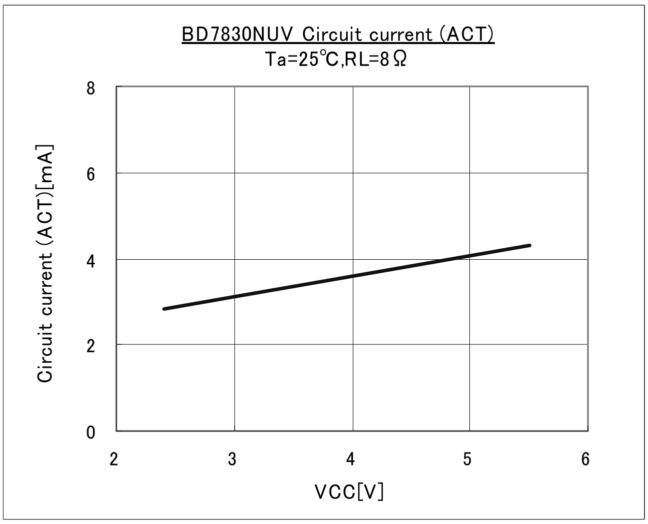


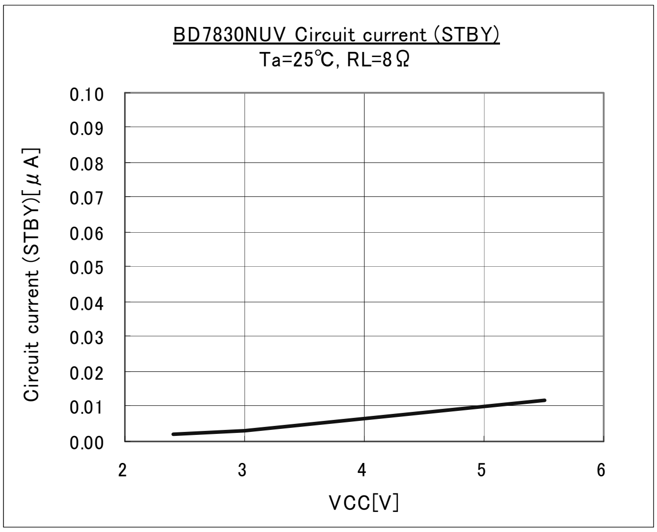


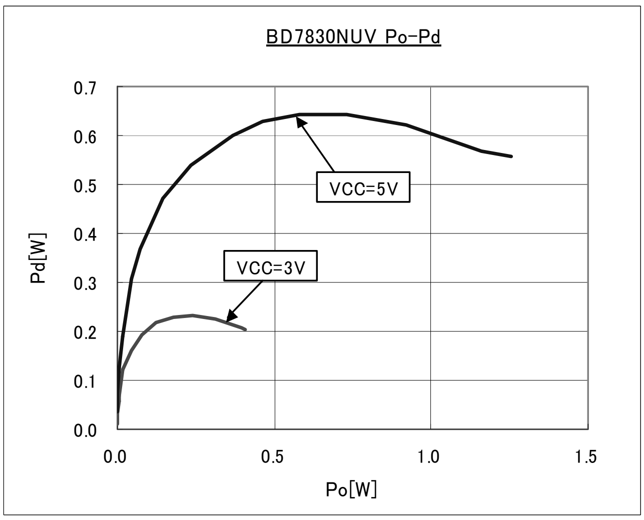
●Typical Characteristics (2)

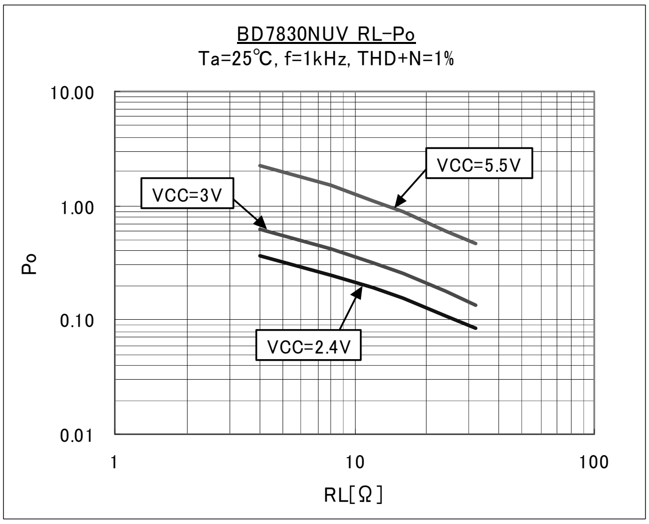












●**Notes for use**

1) The above numerical values and data are typical values for the design, which are not guaranteed.

2) The application circuit examples can be reliably recommended, but their characteristics should be checked carefully before use. When using external component constants that have been modified, determine an ample margin that takes into consideration variation among the external components and Rohm's LSI IC chips, including variation in static characteristics and transient characteristics.

3) Absolute maximum ratings
This IC may be damaged if the absolute maximum ratings for the applied voltage, temperature range, or other parameters are exceeded. Therefore, avoid using a voltage or temperature that exceeds the absolute maximum ratings. If it is possible that absolute maximum ratings will be exceeded, use fuses or other physical safety measures and determine ways to avoid exceeding the IC's absolute maximum ratings. The above numerical values and data are typical values for the design, which are not guaranteed.

4) GND pin's potential
Try to set the minimum voltage for GND pin's potential, regardless of the operation mode.
Check that the voltage of each pin does not go below GND pin's voltage, including transient phenomena.

5) Shorting between pins and mounting errors
When mounting the IC chip on a board, be very careful to set the chip's orientation and position precisely. When the power is turned on, the IC may be damaged if it is not mounted correctly. The IC may also be damaged if a short occurs (due to a foreign object, etc.) between two pins, between a pin and the power supply, or between a pin and the GND.

6) Shorting output pin
When output pin (5,8pin) is shorted to VCC or GND, the IC may be damaged by over current, so be careful in operation.

7) Thermal design
Ensure sufficient margins to the thermal design by taking in to account the allowable power dissipation during actual use modes, because this IC is power amp.
When excessive signal inputs which the heat dissipation is insufficient condition, it is possible that TSD (thermal shutdown circuit) is active.
TSD is protection of the heat by excessive signal inputs, it is not protection of the shorting output to VCC or GND.

8) Shorted pins and mounting errors
When the output pins (pins 5 and 8) are connected to VCC and GND, the thermal shutdown function repeatedly switches between shutdown (OFF) and cancel (ON). Note with caution that chip damage may occur if these connections remain for a long time.

9) Operating range
The rated operating power supply voltage range(VCC=+2.4～+5.5V) and the rated operation temperature range (Ta=-40～+85℃) are the range by which basic circuit functions is operated.
It is not guaranteed a specification and a rated output power about all operating power supply voltage range or operation temperature range.

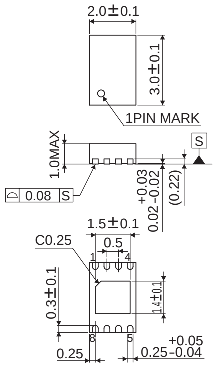
10) Operation in strong magnetic fields
Note with caution that operation faults may occur when this IC operates in a strong magnetic field.

●Ordering part number

B	D		7	8	3	0		N	U	V	-	T	R

- Part No. (BD)
- Part No. (7830)
- Package: NUV:VSON008V2030
- Packaging and forming specification: TR: Embossed tape and reel

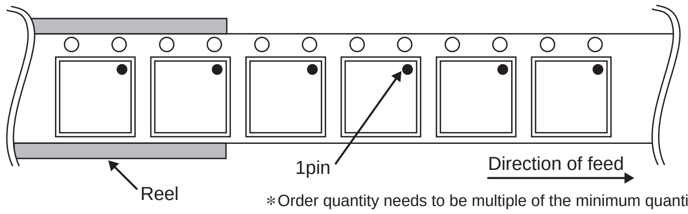
VSON008V2030



(Unit : mm)

<Tape and Reel information>

Tape	Embossed carrier tape
Quantity	3000pcs
Direction of feed	TR (The direction is the 1pin of product is at the upper right 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.

Notes

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