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Small-sized Class-D Speaker Amplifiers

Analog Input
Monaural Class-D Speaker Amplifier

BD5469GUL

General Description

BD5469GUL is a monaural Class-D speaker amplifier that has integrated ALC function suitable for mobile phones, portable type electronic devices, etc. LC filter at the speaker output is not needed. The IC forms a monaural speaker amplifier using just 3 external components. ALC, short for Automatic Level Control, is a function that automatically adjusts the level of suppression to avoid distortion (clipping) of the output waveform during excessive input. The time until the suppression of the output level is released is called the release time (or recovery time). This IC has a typical release time of 262ms/1dB which suits music play applications.
Through Class-D operation, the IC can achieve high efficiency and low power consumption which makes it suitable for battery driven applications. The current consumption in shutdown mode is lowered to 0.01µA(Typ). Startup time from shutdown mode to active mode is fast and pop noise is minimized which enables it to withstand repeated active and shutdown modes.

Features

- Integrated Digital ALC (Automatic Level Control) Function.
- External parts : 3 components.
- Ultra slim type package: 9 pin WL-CSP(1.7×1.7×0.55mmMax).
- Pin Compatible Specs.
  BD5460/61GUL
  (No ALC Function, Fixed Output Gain)
  BD5465/66/68GUL
  (ALC Function, Fixed Output Gain)
- ALC release (recovery) time : 262ms/1dB (Typ).
- Output Power Limit
  : 0.88W (Typ) [V_{DD}=4.2V, R_L=8Ω, THD+N ≤ 1%]
  : 0.9W (Typ) [V_{DD}=3.7V, R_L=6Ω, THD+N ≤ 1%]
  : 0.64W (Typ) [V_{DD}=3.6V, R_L=8Ω, THD+N ≤ 1%]
- Audio Analog Input (has option for either single-end input or differential input).
- No need for output LC filter
- Pop noise suppression circuit
- Shutdown Mode (used as mute at the same time) [low shutdown current = 0.01µA (Typ)]
- Built-in protection circuits: output short protection, high temperature protection, under voltage protection

Applications

Mobile Phones, Portable Audio Devices, PND, DSC, Note-PC etc.

Key Specifications

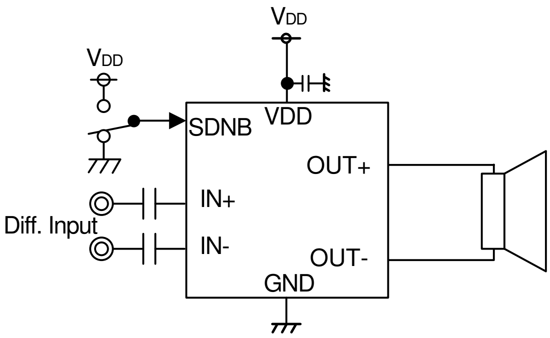
- Supply Voltage Range: 2.5V to 5.5V
- THD+N: 0.2%(0.3W, R_L=8Ω, Typ)
- Switching Frequency: 250kHz(Typ)
- Shutdown Current: 0.01µA (Typ)
- Operating Temperature Range: -40°C to +85°C

Package

	W(Typ) x D(Typ) x H(Max)
VCSP50L1	1.70mm x 1.70mm x 0.55mm

VCSP50L1

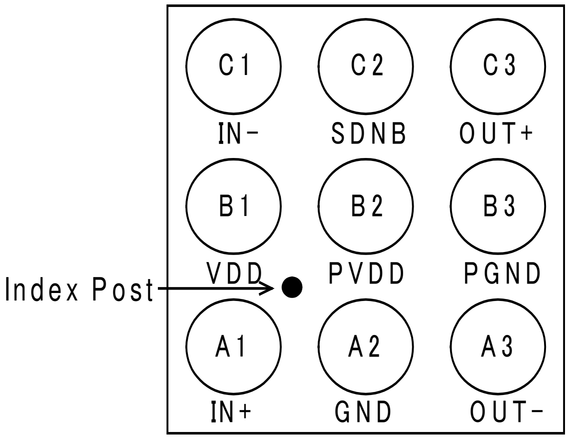
Typical Application Circuit



○Product structure : Silicon monolithic integrated circuit ○This product has no designed protection against radioactive rays

Pin Configuration

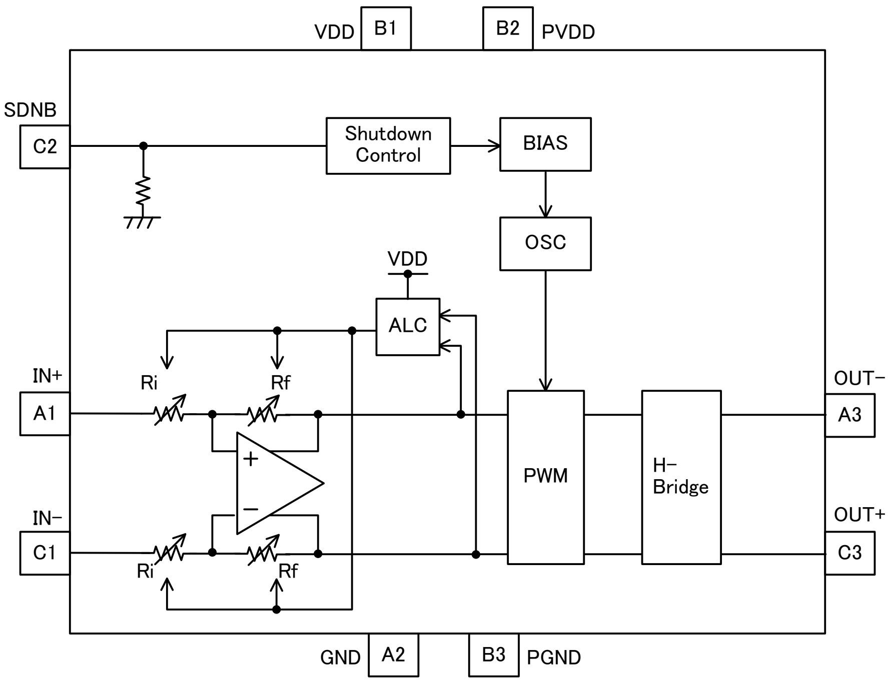
(Bottom View)



Pin Descriptions

Pin No.	Pin Name	Function
A1	IN+	Audio differential input positive terminal
A2	GND	GND terminal (signal)
A3	OUT-	Class-D BTL output negative terminal
B1	VDD	VDD terminal (signal)
B2	PVDD	VDD terminal (power)
B3	PGND	GND terminal (power)
C1	IN-	Audio differential input negative terminal
C2	SDNB	Shutdown control terminal
C3	OUT+	Class-D BTL output positive terminal

Block Diagram



Absolute Maximum Ratings (Ta = 25°C)

Parameter	Symbol	Limit	Unit
Supply Voltage [VDD, PVDD]	VDD PVDD	-0.3 to +7.0	V
Power Dissipation	Pd	0.69 (Note 1)	W
Operating Temperature Range	Topr	-40 to +85	°C
Storage Temperature Range	Tstg	-55 to +150	°C
Maximum Junction Temperature	Tjmax	150	°C
SDNB, IN+, IN- Voltage	V_{IN}	-0.3 to +7.0	V
OUT Voltage	V_{OUT}	-0.3 to +7.0	V

(Note 1) Derate by 5.52 mW/°C when operating above Ta = 25°C (Mount on 1-layer 70.0mm x 70.0mm x 1.6mm board)

Caution: Operating the IC over the absolute maximum ratings may damage the IC. The damage can either be a short circuit between pins or an open circuit between pins and the internal circuitry. Therefore, it is important to consider circuit protection measures, such as adding a fuse, in case the IC is operated over the absolute maximum ratings.

Recommended Operating Conditions (Ta= -40°C to +85°C)

Parameter	Symbol	Min	Typ	Max	Unit
Supply Voltage	VDD PVDD	2.5	3.6	5.5	V
Common Mode Input Voltage Range	V_{SW}	+0.5	-	V_{DD}-0.8	V
Minimum Load Impedance	R_L	3.6	-	-	Ω

Electrical Characteristics (Unless otherwise specified, V_{DD}=3.6V, Ta=25°C)

Parameter		Symbol	Limit Min	Limit Typ	Limit Max	Unit	Conditions
Whole Circuit							
Circuit Current (No Signal)		I_{CC}	-	3	6	mA	IC Active, No Load V_{SDNB} =V_{DD}
Circuit Current (Shutdown)		I_{SDN}	-	0.01	2	µA	IC Shutdown V_{SDNB} =GND
Audio Circuit							
Limit Output Power		P_O	0.044 x V_{DD}^2	0.050 x V_{DD}^2	0.055 xVDD^2	W	BTL, f=1kHz, R_L=8Ω THD+N ≤ 1% , (Note 2)
Total Harmonic Distortion		THD+N	-	0.2	1	%	BTL, f_{IN}=1kHz, R_L=8Ω P_O =0.3W, (Note 2)
Maximum Gain		G_{MAX}	12	13	14	dB	BTL, (Note 2)
ALC Limit Level		V_{LIM}	1.68 x V_{DD}	1.78 x V_{DD}	1.89 x V_{DD}	V_{P-P}	BTL, (Note 2)
ALC Release Level		V_{REL}	1.34 x V_{DD}	1.41 x V_{DD}	1.5 x V_{DD}	V_{P-P}	BTL, (Note 2)
Switching Frequency		f_{OSC}	150	250	350	kHz	
Start-up Time		t_{ON}	0.73	1.02	1.71	msec	
Audio Input Resistance		R_I	47	72	97	kΩ	Gain=13dB
Control Circuit							
SDNB Terminal Threshold Voltage	H	V_{SDNBH}	1.4	-	V_{DD}	V	IC Active
	L	V_{SDNBL}	0	-	0.4	V	IC Shutdown
SDNB Terminal Inflow Current	H	I_{SDBNH}	24	48	72	µA	V_{SDNB} =3.6V
	L	I_{SDNBL}		-	±5	µA	V_{SDNB} =0V

(Note 2) Filter bandwidth for measurement：400Hz to 30kHz, LC filter for AC measurement : L=22µH / C=1µF, BTL：Voltage between A3,C3

Typical Performance Curves

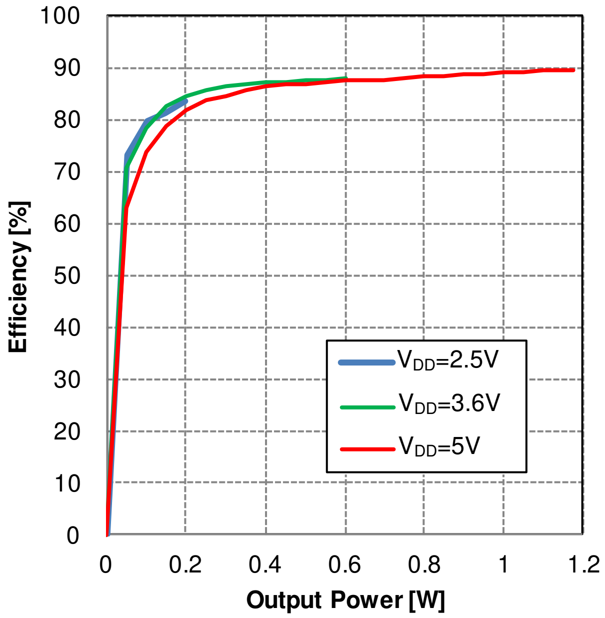


Figure 1. Efficiency vs Output Power
(f=1kHz, R_L=8Ω+33μH)

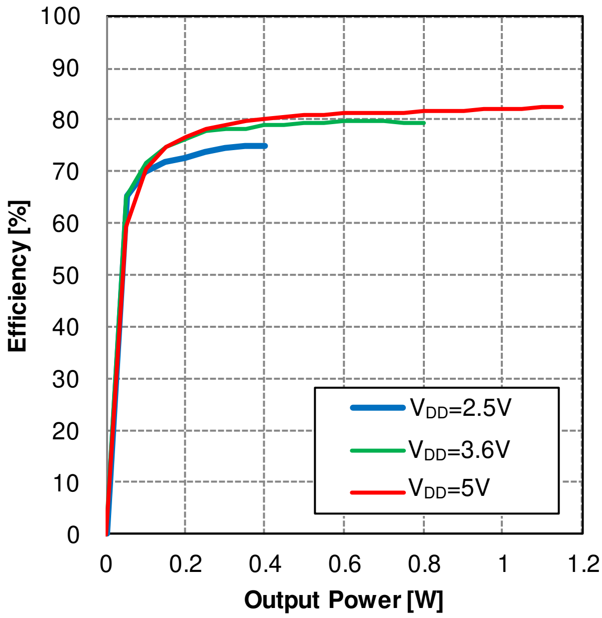


Figure 2. Efficiency vs Output Power
(f=1kHz, R_L=4Ω+33μH)

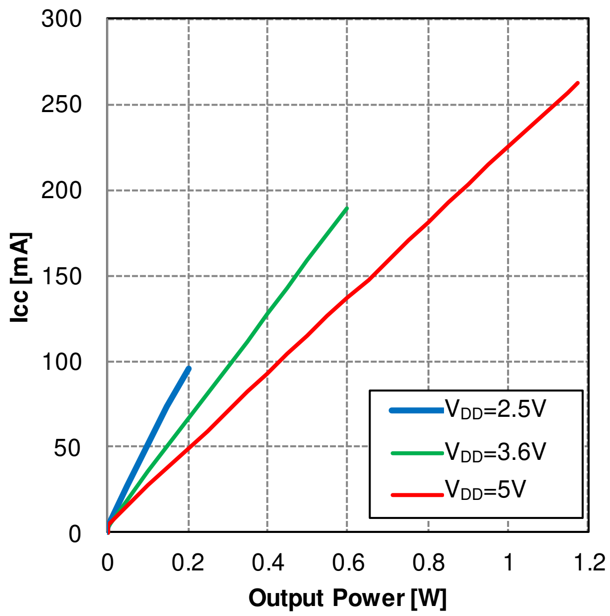


Figure 3. Supply Current vs Output Power
(f=1kHz, R_L=8Ω+33μH)

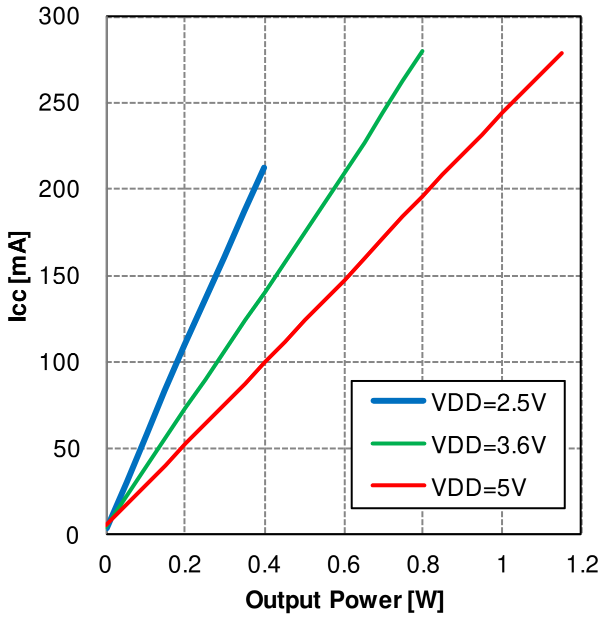


Figure 4. Supply Current vs Output Power
(f=1kHz, R_L=4Ω+33μH)

Typical Performance Curves - continued

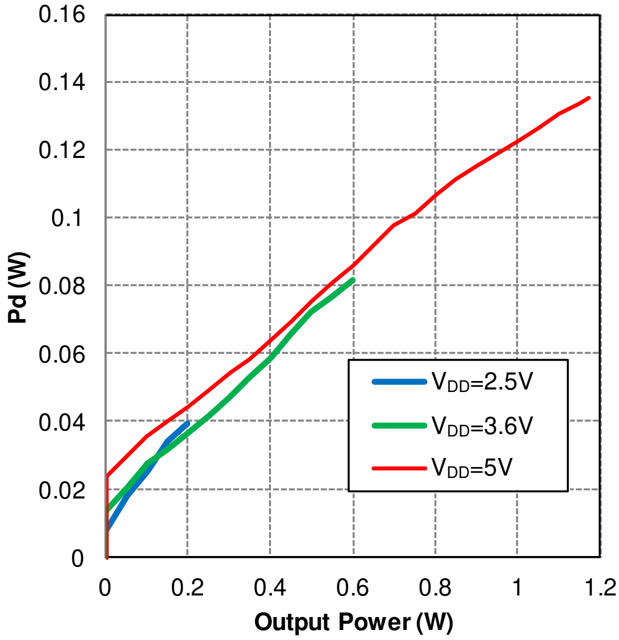


Figure 5. Power Dissipation vs Output Power
(f=1kHz, R_L=8Ω+33μH)

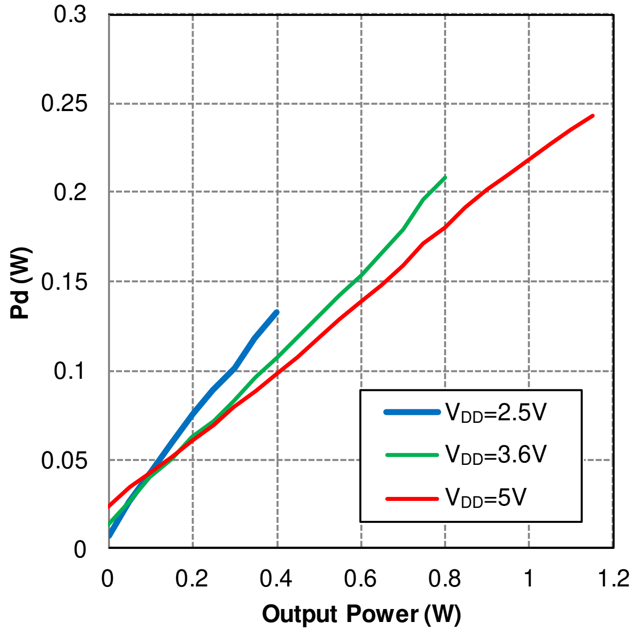


Figure 6. Power Dissipation vs Output Power
(f=1kHz, R_L=4Ω+33μH)

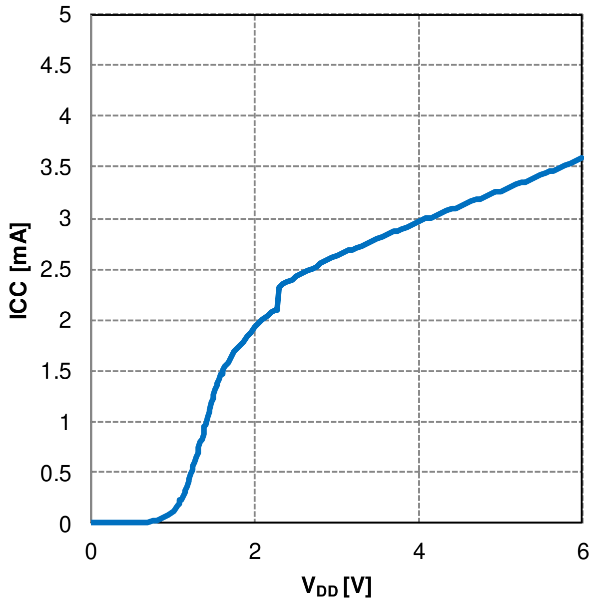


Figure 7. Supply Current vs Power Supply
(No Load, No Signal)

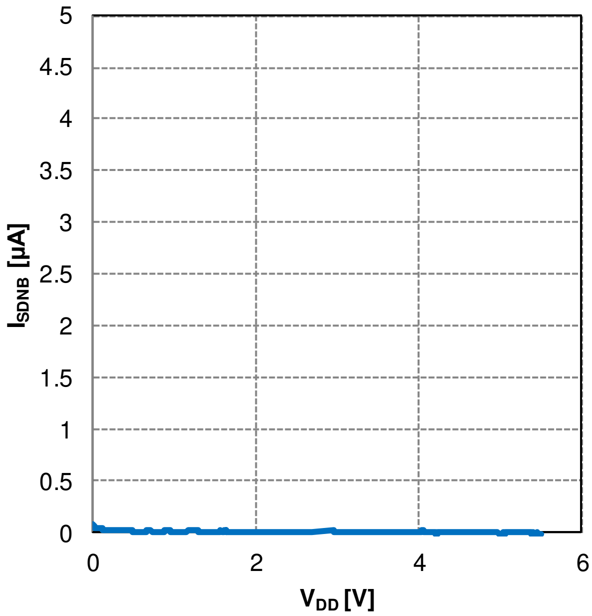


Figure 8. Shutdown Current vs Power Supply
(No Load, No Signal)

Typical Performance Curves - continued

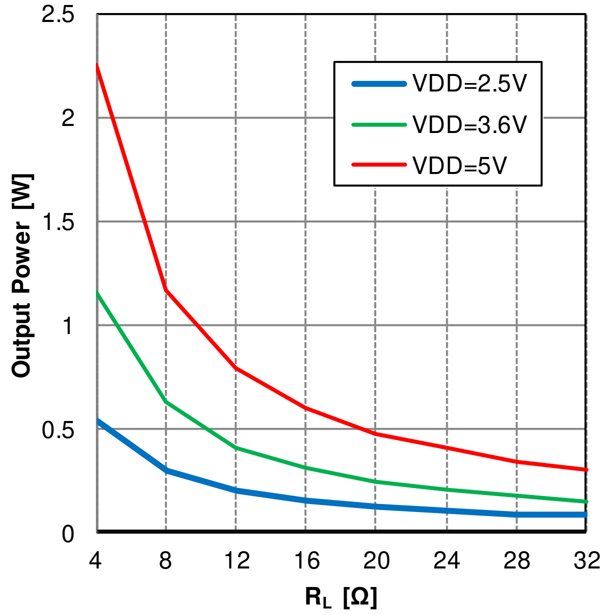


Figure 9. Output Power vs Load Resistance
(f=1kHz)

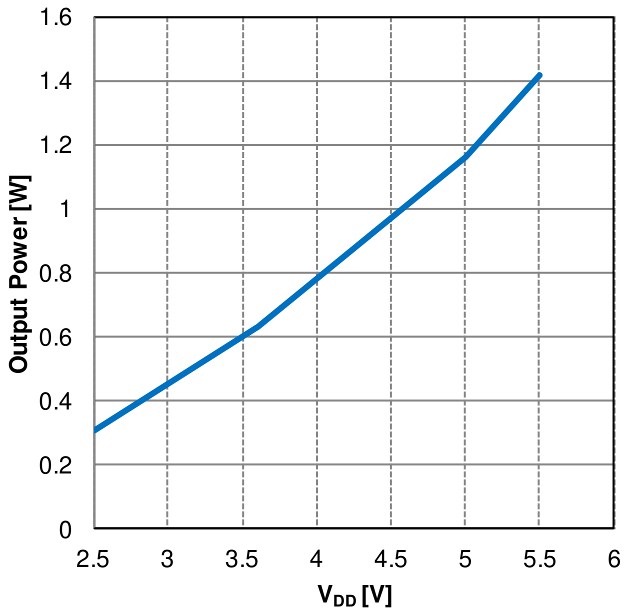


Figure 10. Output Power vs Power Supply
(f=1kHz, R_L=8Ω)

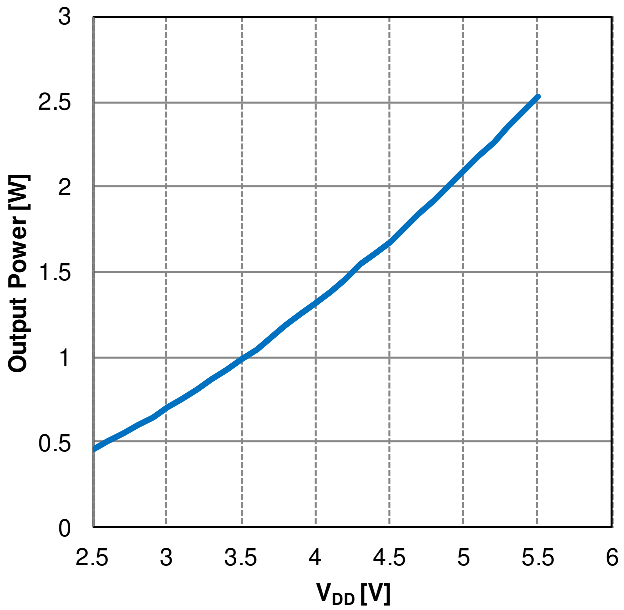


Figure 11. Output Power vs Power Supply
(f=1kHz, R_L=4Ω)

Typical Performance Curves - continued

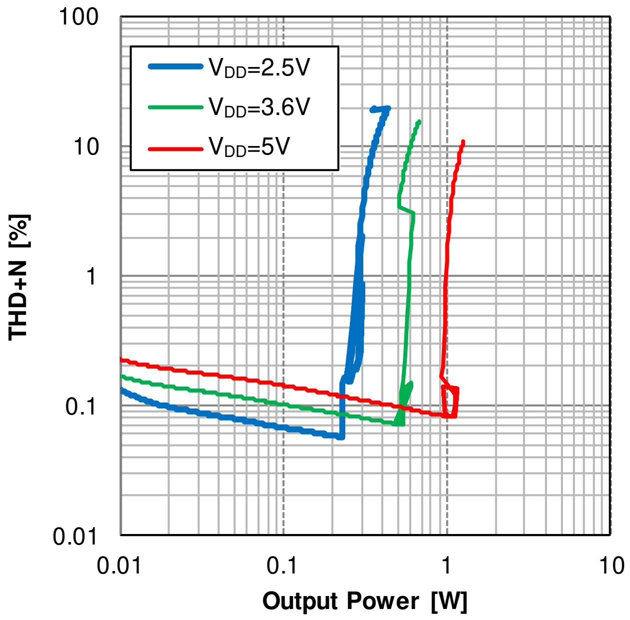


Figure 12. THD+N vs Output Power
(f=1kHz, R_L=8Ω, 400Hz-30kHz BPF)

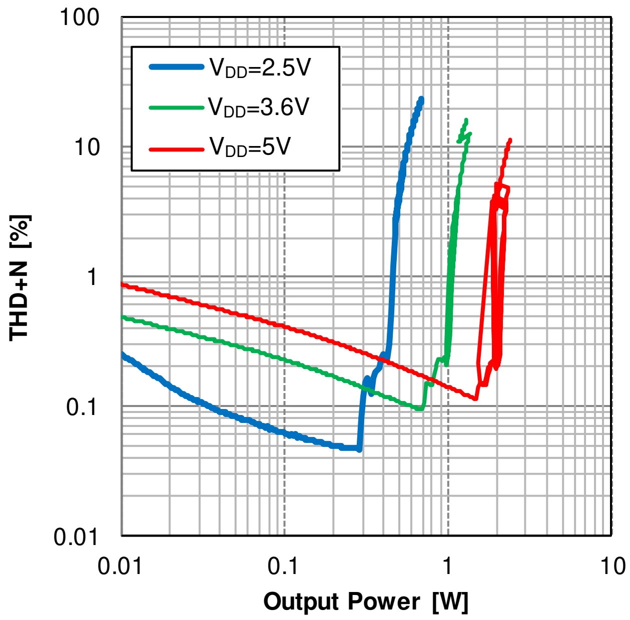


Figure 13. THD+N vs Output Power
(f=1kHz, R_L=4Ω, 400Hz-30kHz BPF)

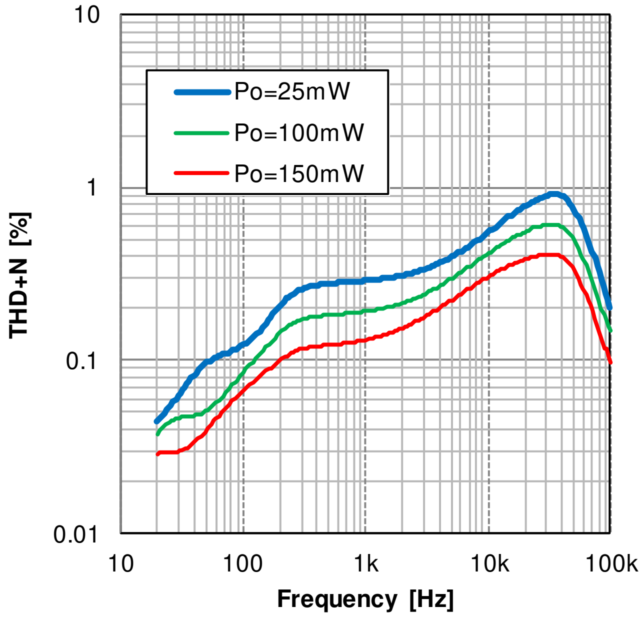


Figure 13. THD+N vs Frequency
(V_{DD}=5.0V, f=1kHz, R_L=8Ω, 400Hz-30kHz BPF)

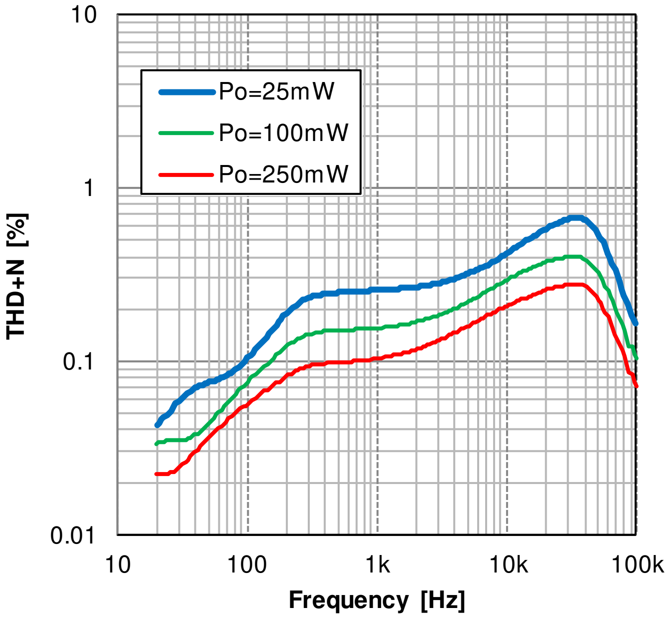


Figure 14. THD+N vs Frequency
(V_{DD}=3.6V, f=1kHz, R_L=8Ω, 400Hz-30kHz BPF)

Typical Performance Curves - continued

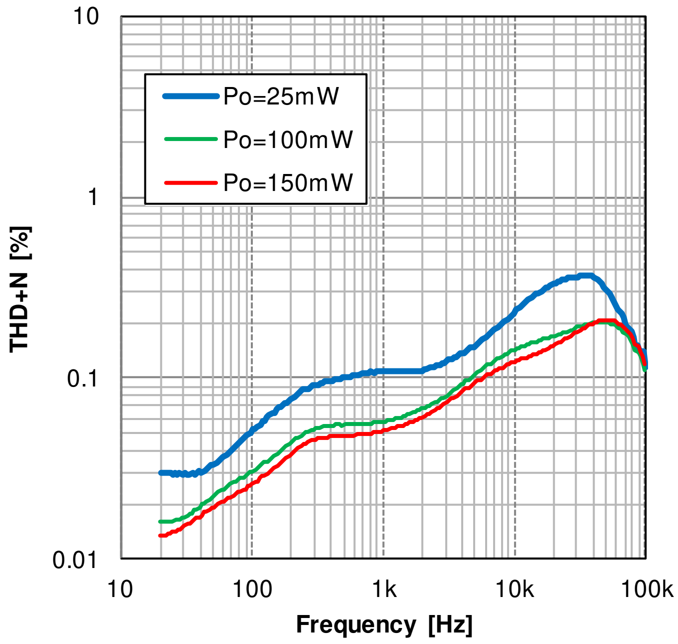


Figure 15. THD+N vs Frequency
(V_{DD}=2.5V, f=1kHz, R_L=8Ω, 400Hz-30kHz BPF)

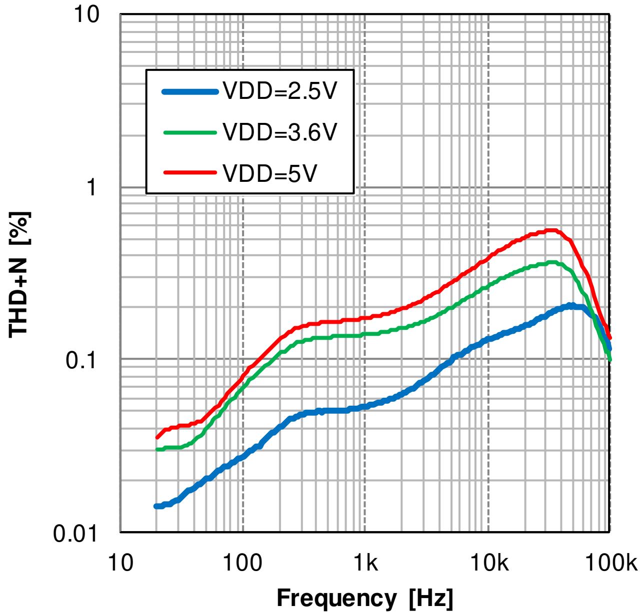


Figure 16. THD+N vs Frequency
(f=1kHz, R_L=8Ω, Po=125mW, 400Hz-30kHz BPF)

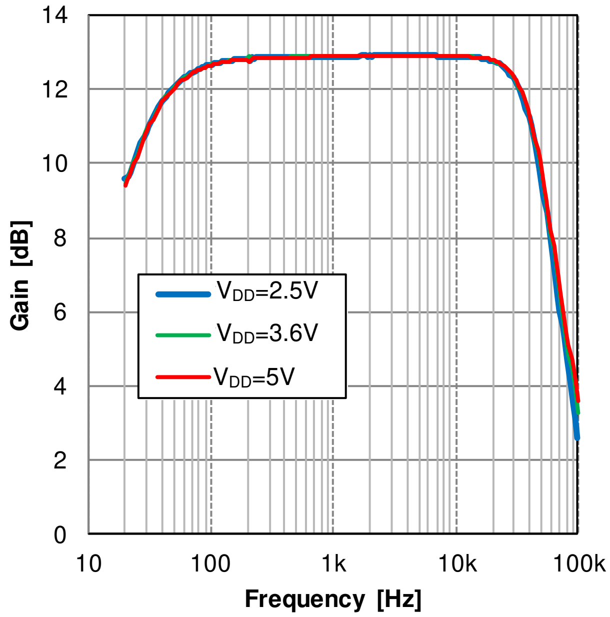


Figure 17. Gain vs Frequency
(Vin=0.5V_{P-P}, R_L=8Ω, 400Hz-30kHz BPF)

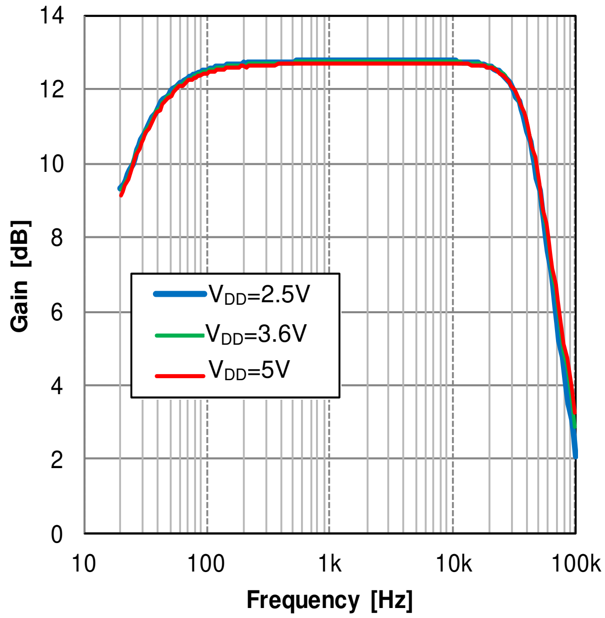


Figure 18. Gain vs Frequency
(Vin=0.5V_{P-P}, R_L=4Ω, 400Hz-30kHz BPF)

Typical Performance Curves - continued

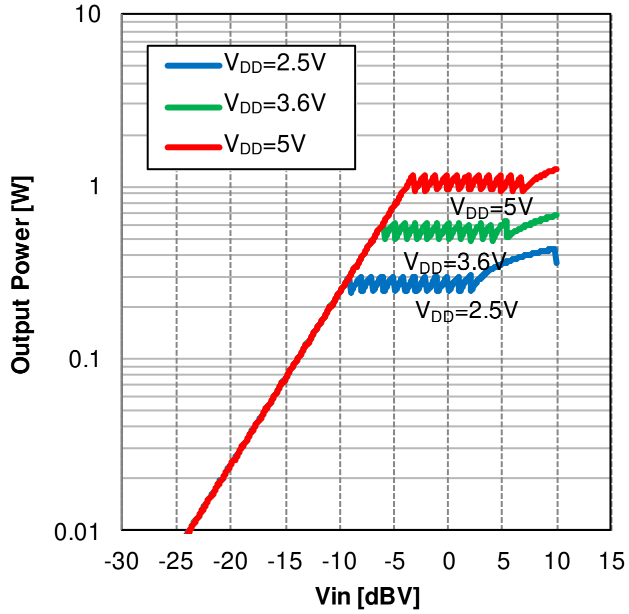


Figure 19. Output Power vs Input Level
(f=1kHz, R_L=8Ω)

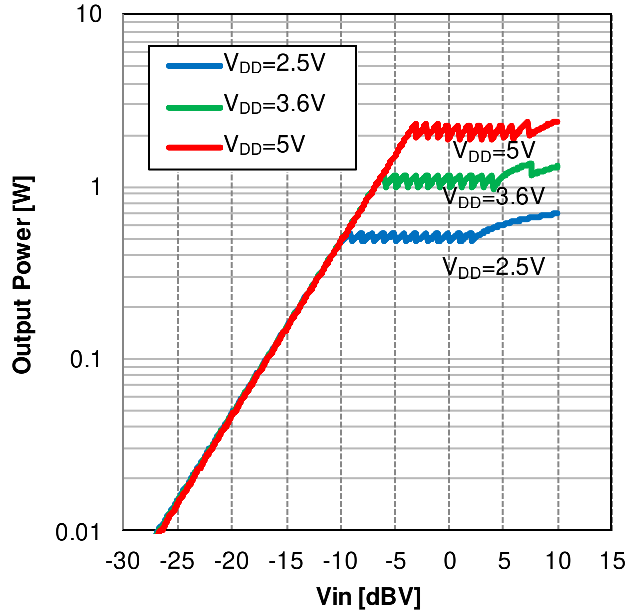


Figure 20. Output Power vs Input Level
(f=1kHz, R_L=4Ω)

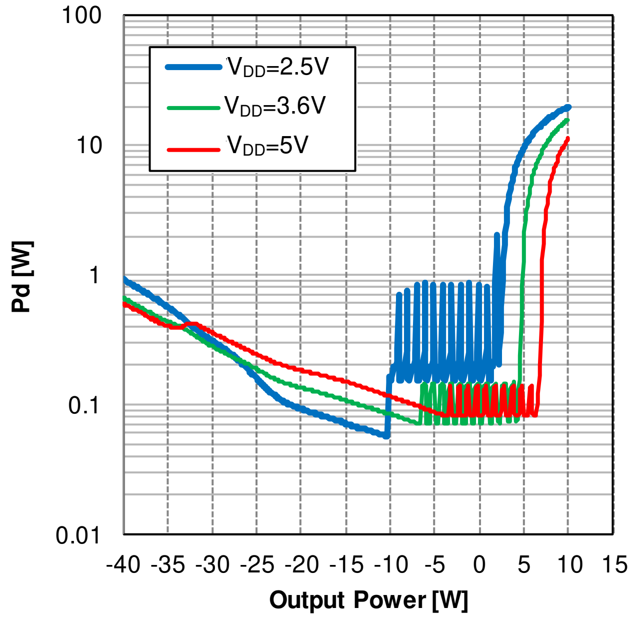


Figure 21. THD+N vs Output Power
(f=1kHz, R_L=8Ω, 400Hz-30kHz BPF)

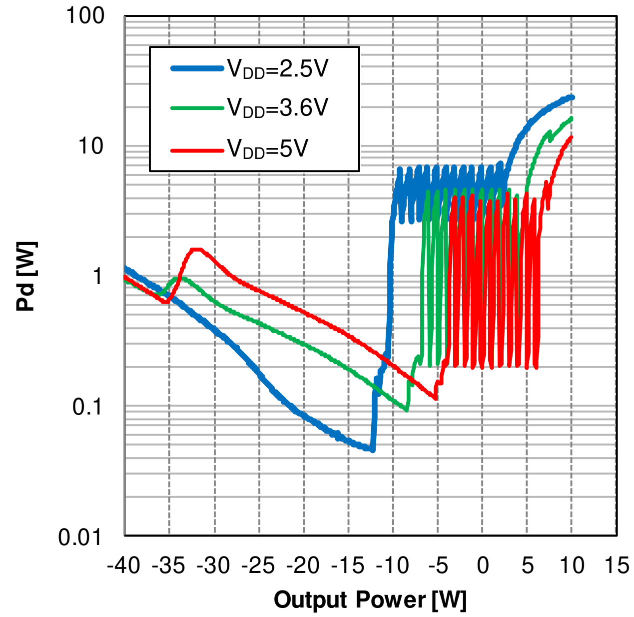


Figure 22. THD+N vs Output Power
(f=1kHz, R_L=4Ω, 400Hz-30kHz BPF)

Typical Performance Curves - continued

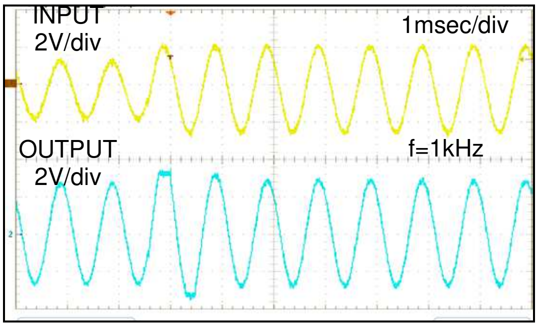


Figure 23. ALC Limit waveform
(V_{DD}=3.6V, R_L=8Ω)

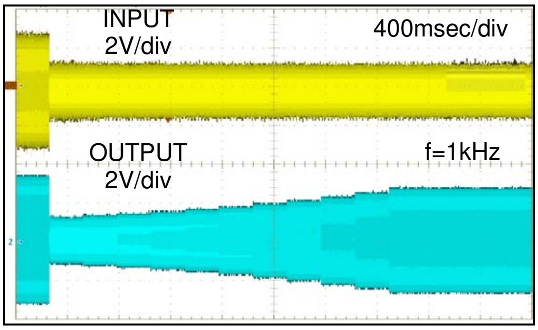


Figure 24. ALC Release waveform
(V_{DD}=3.6V, R_L=8Ω)

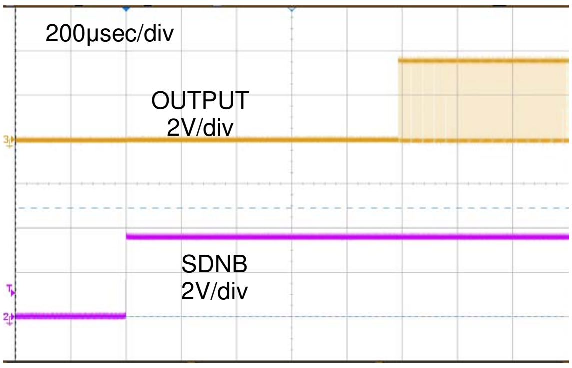


Figure 25. Start waveform
(V_{DD}=3.6V, R_L=8Ω)

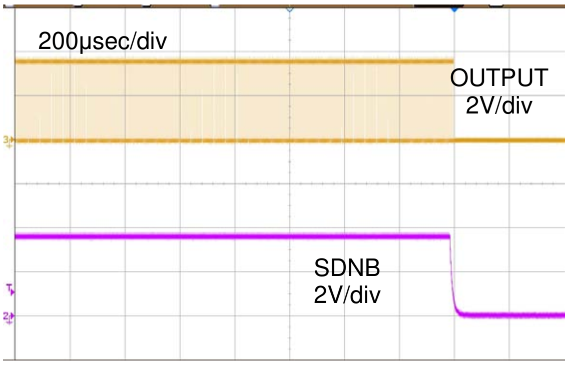


Figure 26. Shutdown waveform
(V_{DD}=3.6V, R_L=8Ω)

Application Information

1. Shutdown Control

Control terminal	Condition
SDNB	
H	IC operation (active)
L	IC stop (shutdown)

2. ALC Parameter

ALC Parameter		
Attack Time (Typ)	Release Time (Typ)	Gain Switch Step(Typ)
~1ms/1dB@f_{IN}=100Hz ~0.5ms/1dB@ f_{IN}=1kHz ~0.05ms/1dB@ f_{IN}=10kHz	262ms/1dB @ f_{IN}=100Hz to 10kHz	±1dB

The gain switch timing during ALC operation occurs at zero cross point of audio output voltage.
For that, attack time and release time will change at input frequency “f_{IN}”.
ALC Parameter is fixed. ALC operation doesn’t correspond to impulse noise.

3. Protection Function Description

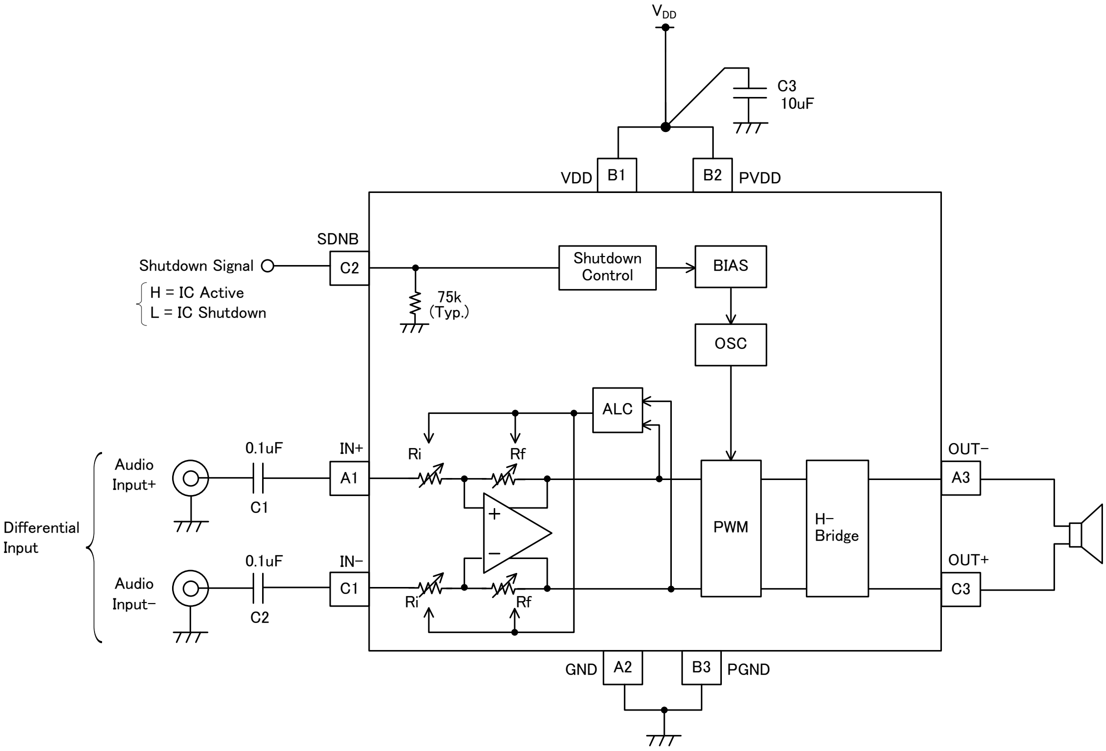
Protection Function	Detecting and Releasing Condition		Speaker PWM Output
Output Short Protection	Detecting condition	Detecting current= 2.5A (Typ)	High Z (Latch)
High Temperature Protection	Detecting condition	Chip temperature above 180°C (Typ)	High Z
	Releasing condition	Chip temperature below 110°C (Typ)	Normal operation
Under Voltage Protection	Detecting condition	Power supply voltage below 2.2V (Typ)	1kΩ pulldown
	Releasing condition	Power supply voltage above 2.3V (Typ)	Normal operation

Once an IC is latched, the circuit is not released automatically even after the detecting status is removed.
Procedure 1 or 2 below is needed for recovery.

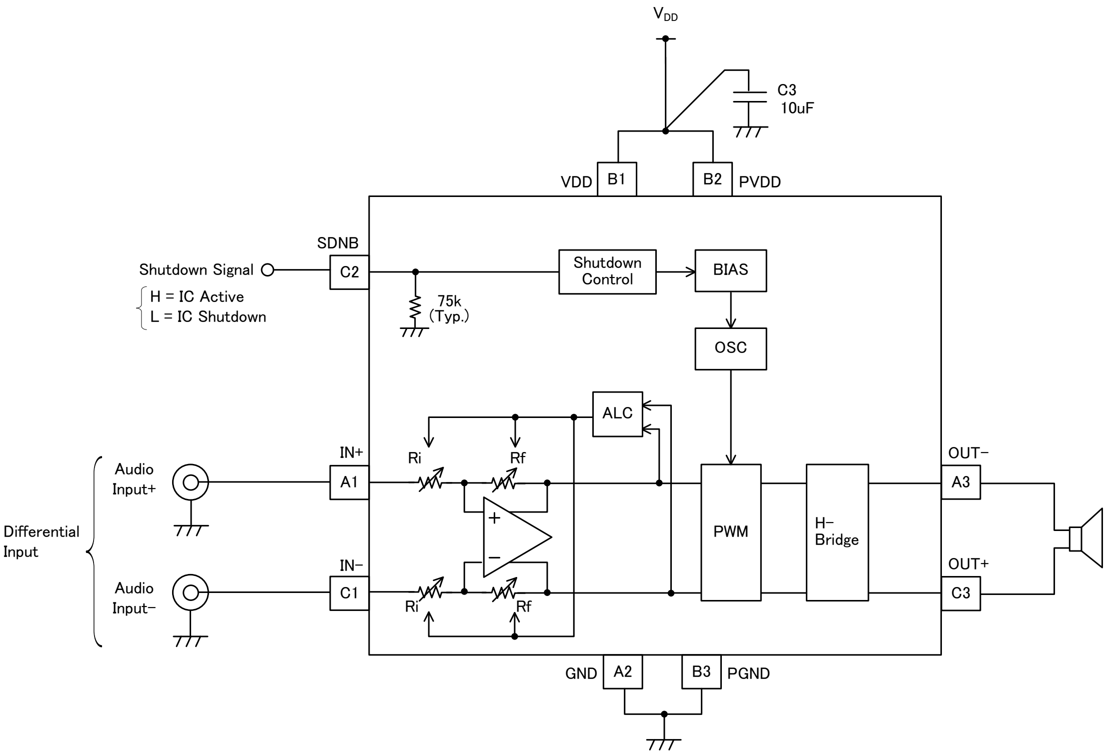
1 SDNB pin is turned Low once. After the soft mute transition time, SDNB pin is returned to High again.
2 Power supply is turned on again after dropping to V_{DD}<1V (10ms (Min) holding time) in which the internal power ON reset circuit activates.

Application Examples

Application Circuit Example 1: Differential Input (With Input Coupling Capacitor)

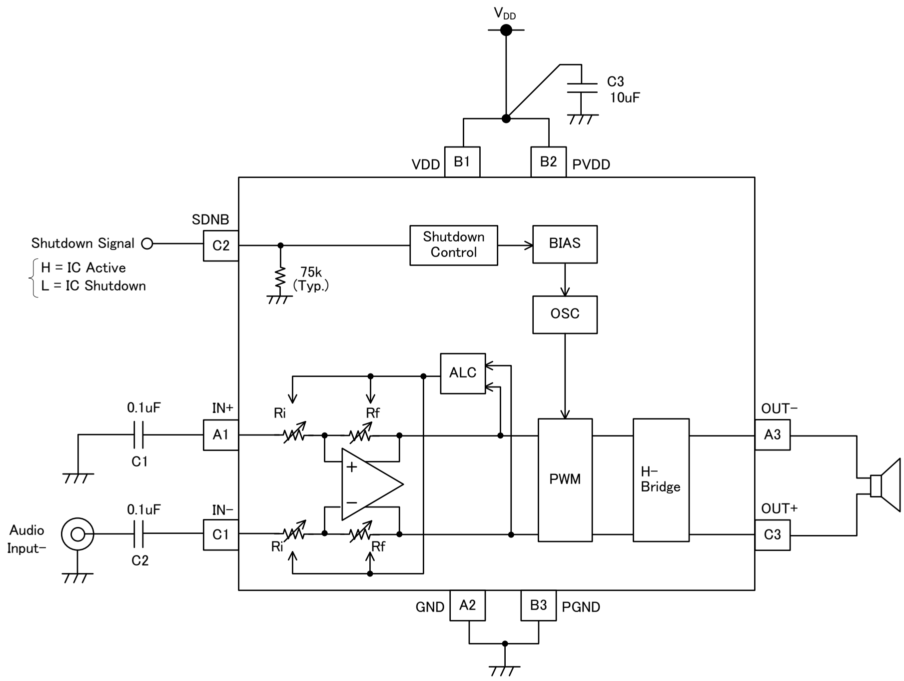


Application Circuit Example 2: (Without Input Coupling Capacitor)



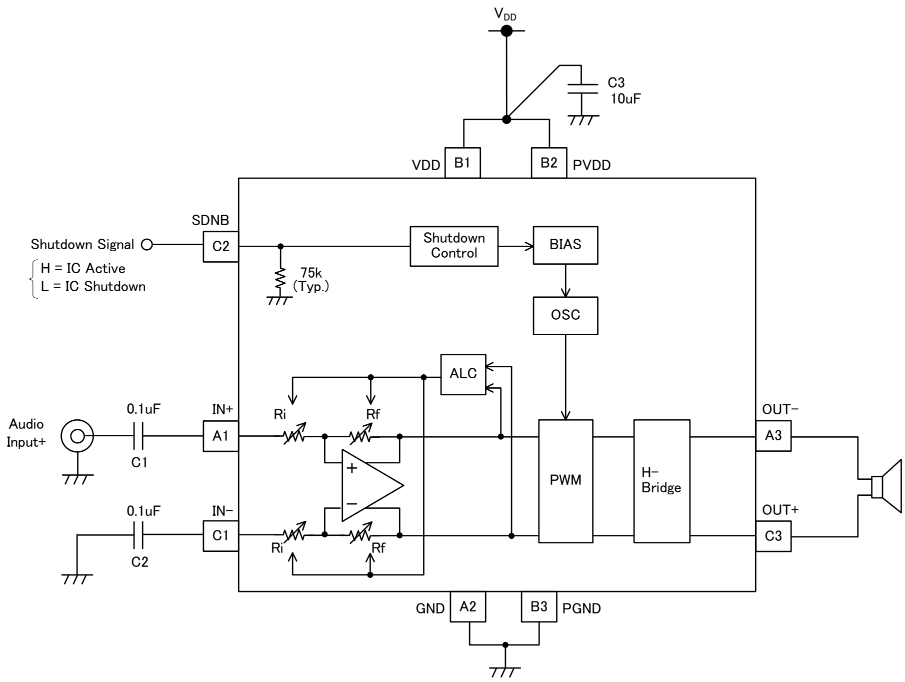
The BD5469GUL does not require input coupling capacitors if the design uses a differential source that is biased from 0.5V to V_{DD}-0.8V.

Application Circuit Example 3: Single End Input (IN-)



The output (OUT+ to OUT-) and IN- are in reverse phase.

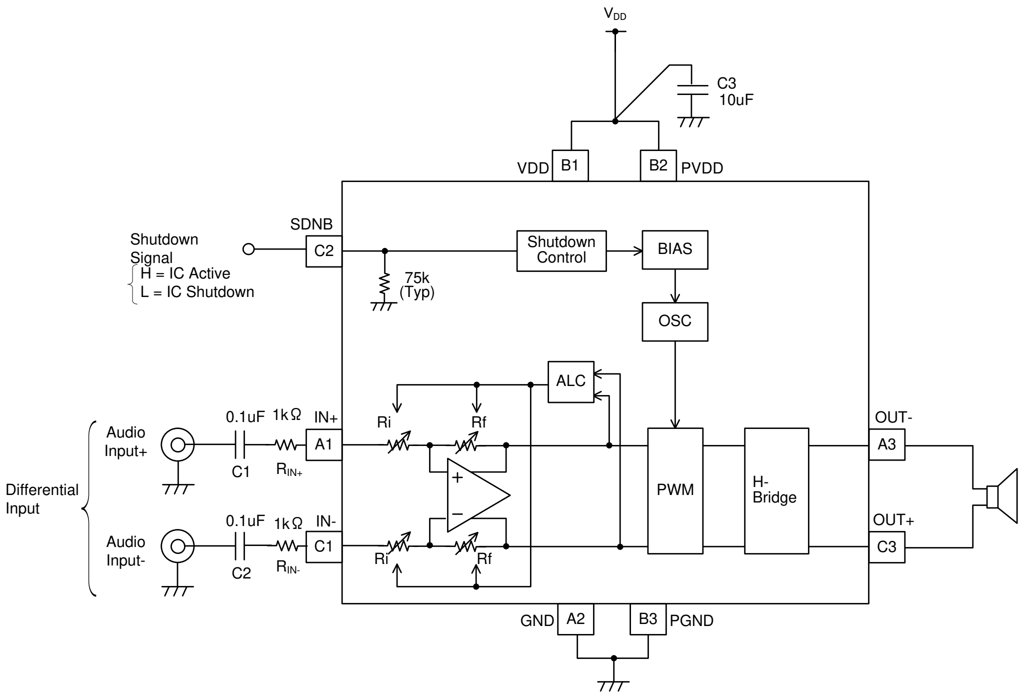
Application Circuit Example 4: Single End Input (IN+)



The output (OUT+ to OUT-) and IN+ are in phase.

Input pin should not be left open through the input coupling capacitor. Please connect to GND as seen on the example above. Audio input pin should be in “mute” condition and not “open” condition when there’s no input signal.

Application Circuit Example 5: Differential Input (With Input Coupling Capacitor)
When it is not possible to drive in 1kΩ pull-down at SDNB=L.



The input pin uses a 1kΩ pull-down when PDNB=L (Please refer to the I/O equivalent circuit chart). Therefore, please take note of the drive current capability of the audio input. Please insert 1kΩ in the terminal as shown in the above figure when the drive current capability of the input line is insufficient. There is no influence at the ALC level of the output when 1kΩ is inserted.

Selecting External Components

(1) Input Coupling Capacitor (C1, C2)
The input coupling capacitor is 0.1µF.
Input impedance during maximum gain of 13dB is 72kΩ (Typ). A high-pass filter is composed by the input coupling capacitor and the input impedance.
Cut-off frequency “fc” is calculated using the formula below, given the input coupling capacitor C=(C1=C2) and input impedance Ri.

$$fc = \frac{1}{2\pi \times Ri \times C} \quad \text{[Hz]}$$

In case of Ri=72kΩ and C=(C1=C2)=0.1µF, the cut-off frequency is about 22Hz.

(2) Power Supply Decoupling Capacitor (C3)
The power supply decoupling capacitor is 10µF. When the capacity value of the power supply decoupling capacitor is made small, it will have an influence to the audio characteristics THD+N, ALC Limit level, ALC Release level. When making it small, be careful with the audio characteristics at actual application. Please use a capacitor having low enough ESR (equivalent series resistance).

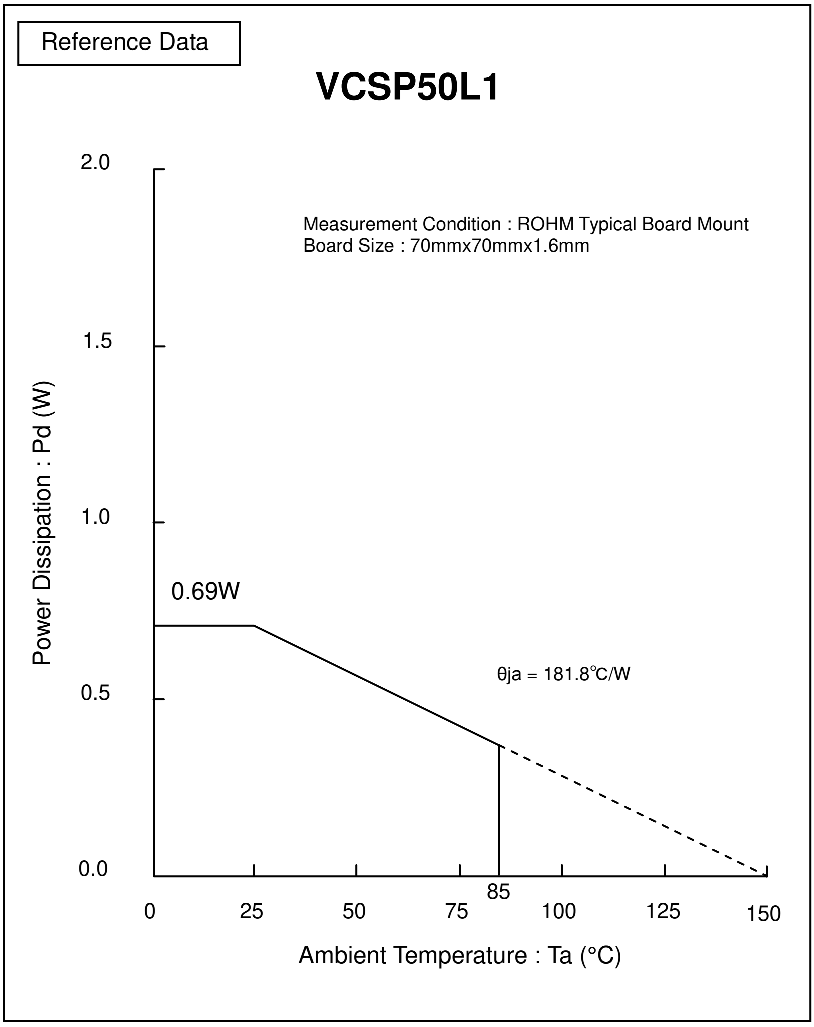
Power Dissipation

The IC Characteristics has a big relation with the temperature that is used. Exceeding the maximum tolerance junction temperature can deteriorate and destroy it. To avoid instant destruction and maintain long-time operation of the IC, there should be extra caution during thermal operation.

Refer to the maximum junction temperature (Tjmax) and the operating temperature range (Topr) in the absolute maximum ratings of the IC, and the Pd-Ta characteristics (Thermal reduction ratio curve) shown below. If input signal is excessive at a state where heat sink is not sufficient, there will be TSD (Thermal Shutdown)

TSD of the chip is detected at around 180°C, and is released at around 120°C or less. Since the aim is to prevent damage on the chip, avoid operating at TSD temperature window for a long period of time because this can deteriorate the IC.

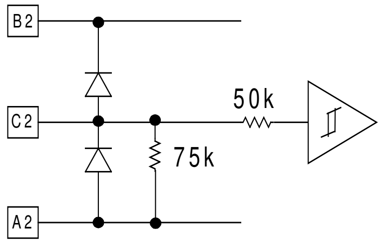
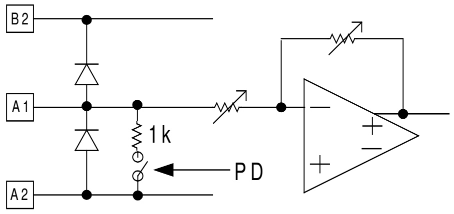
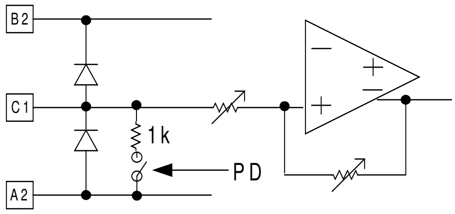
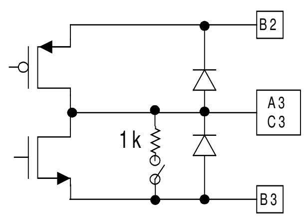
Thermal Reduction Ratio Curve



(Note) This value is the real measurement, but not the guaranteed value.

The value of power dissipation changes based on the board that will be mounted.
The power dissipation may exceed the value on the above graph depending on the heat dissipation efficiency of the mounted board.

I/O Equivalent Circuits (Provided pin voltages are typical values)

Pin No.	Pin Name	Pin Voltage (TYP)	Pin Descriptions	Internal Equivalent Circuits
C2	SDNB	0V	Shutdown control terminal H: Active L: Shutdown	
A1	IN+	0V	Audio differential input positive terminal 1kΩ pull-down at PDNB=L	
C1	IN-	0V	Audio differential input negative terminal 1kΩ pull-down at PDNB=L	
A3	OUT-	0V	Class-D BTL output negative terminal	
C3	OUT+		Class-D BTL output positive terminal	
B1	VDD	-	VDD terminal (signal)	-
B2	PVDD	-	VDD terminal (power)	-
A2	GND	-	GND terminal (signal)	-
B3	PGND	-	GND terminal (power)	-

Operational Notes

1. **Reverse Connection of Power Supply**
   Connecting the power supply in reverse polarity can damage the IC. Take precautions against reverse polarity when connecting the power supply, such as mounting an external diode between the power supply and the IC's power supply terminals.

2. **Power Supply Lines**
   Design the PCB layout pattern to provide low impedance supply lines. Separate the ground and supply lines of the digital and analog blocks to prevent noise in the ground and supply lines of the digital block from affecting the analog block. Furthermore, connect a capacitor to ground at all power supply pins. Consider the effect of temperature and aging on the capacitance value when using electrolytic capacitors.

3. **Ground Voltage**
   Ensure that no pins are at a voltage below that of the ground pin at any time, even during transient condition.

4. **Ground Wiring Pattern**
   When using both small-signal and large-current ground traces, the two ground traces should be routed separately but connected to a single ground at the reference point of the application board to avoid fluctuations in the small-signal ground caused by large currents. Also ensure that the ground traces of external components do not cause variations on the ground voltage. The ground lines must be as short and thick as possible to reduce line impedance.

5. **Thermal Consideration**
   Should by any chance the power dissipation rating be exceeded, the rise in temperature of the chip may result in deterioration of the properties of the chip. The absolute maximum rating of the Pd stated in this specification is when the IC is mounted on a 70mm x 70mm x 1.6mm glass epoxy board. In case of exceeding this absolute maximum rating, increase the board size and copper area to prevent exceeding the Pd rating

6. **Recommended Operating Conditions**
   These conditions represent a range within which the expected characteristics of the IC can be approximately obtained. The electrical characteristics are guaranteed under the conditions of each parameter.

7. **Inrush Current**
   When power is first supplied to the IC, it is possible that the internal logic may be unstable and inrush current may flow instantaneously due to the internal powering sequence and delays, especially if the IC has more than one power supply. Therefore, give special consideration to power coupling capacitance, power wiring, width of ground wiring, and routing of connections.

8. **Operation Under Strong Electromagnetic Field**
   Operating the IC in the presence of a strong electromagnetic field may cause the IC to malfunction.

9. **Testing on Application Boards**
   When testing the IC on an application board, connecting a capacitor directly to a low-impedance output pin may subject the IC to stress. Always discharge capacitors completely after each process or step. The IC's power supply should always be turned OFF completely before connecting or removing it from the test setup during the inspection process. To prevent damage from static discharge, ground the IC during assembly and use similar precautions during transport and storage.

10. **Inter-pin Short and Mounting Errors**
    Ensure that the direction and position are correct when mounting the IC on the PCB. Incorrect mounting may result in damaging the IC. Avoid nearby pins being shorted to each other especially to ground, power supply and output pin. Inter-pin shorts could be due to many reasons such as metal particles, water droplets (in very humid environment) and unintentional solder bridge deposited in between pins during assembly to name a few.

11. **Unused Input Pins**
    Input terminals of an IC are often connected to the gate of a MOS transistor. The gate has extremely high impedance and extremely low capacitance. If left unconnected, the electric field from the outside can easily charge it. The small charge acquired in this way is enough to produce a significant effect on the conduction through the transistor and cause unexpected operation of the IC. So unless otherwise specified, unused input terminals should be connected to the power supply or ground line.

Operational Notes – continued

12. Regarding the Input Pin of the IC

This monolithic IC contains P+ isolation and P substrate layers between adjacent elements in order to keep them isolated. P-N junctions are formed at the intersection of the P layers with the N layers of other elements, creating a parasitic diode or transistor. For example (refer to figure below):

When GND > Pin A and GND > Pin B, the P-N junction operates as a parasitic diode.
When GND > Pin B, the P-N junction operates as a parasitic transistor.

Parasitic diodes inevitably occur in the structure of the IC. The operation of parasitic diodes can result in mutual interference among circuits, operational faults, or physical damage. Therefore, conditions that cause these diodes to operate, such as applying a voltage lower than the GND voltage to an input pin (and thus to the P substrate) should be avoided.

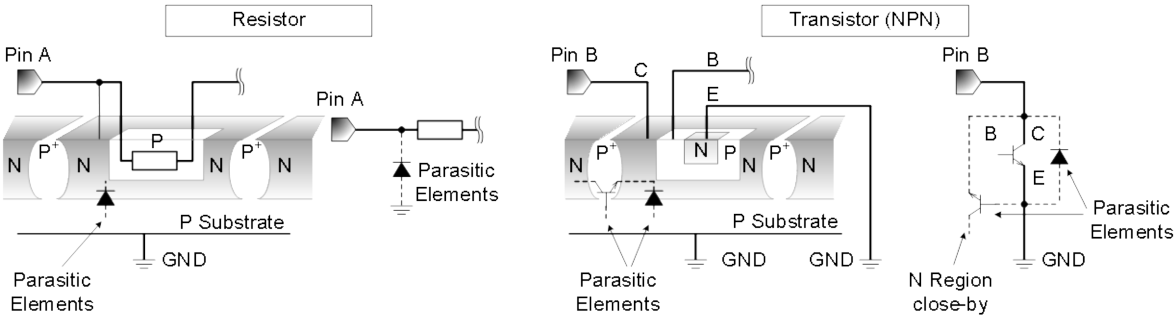


Figure 27. Example of Monolithic IC Structure

13. Ceramic Capacitor

When using a ceramic capacitor, determine the dielectric constant considering the change of capacitance with temperature and the decrease in nominal capacitance due to DC bias and others.

14. Area of Safe Operation (ASO)

Operate the IC such that the output voltage, output current, and power dissipation are all within the Area of Safe Operation (ASO).

15. Thermal Shutdown Circuit (TSD)

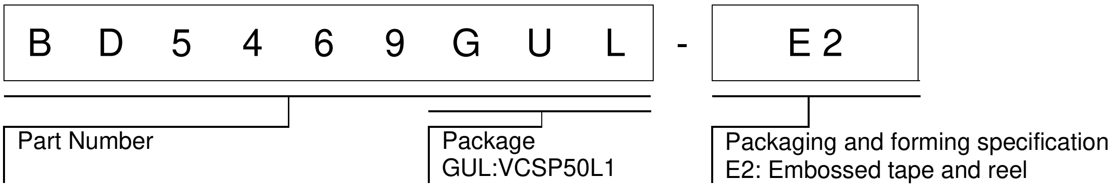
This IC has a built-in thermal shutdown circuit that prevents heat damage to the IC. Normal operation should always be within the IC’s power dissipation rating. If however the rating is exceeded for a continued period, the junction temperature (Tj) will rise which will activate the TSD circuit that will turn OFF all output pins. When the Tj falls below the TSD threshold, the circuits are automatically restored to normal operation.

Note that the TSD circuit operates in a situation that exceeds the absolute maximum ratings and therefore, under no circumstances, should the TSD circuit be used in a set design or for any purpose other than protecting the IC from heat damage.

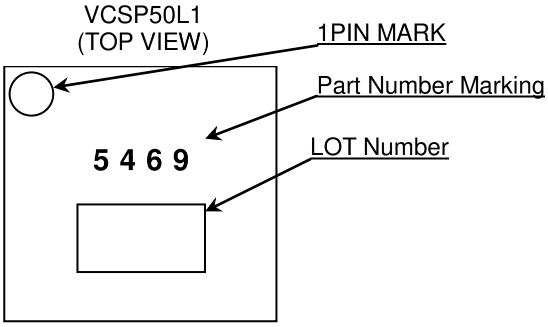
16. Over-Current Protection Circuit (OCP)

This IC has a built-in over-current protection circuit that activates when the output is accidentally shorted. However, it is strongly advised not to subject the IC to prolonged shorting of the output.

Ordering Information



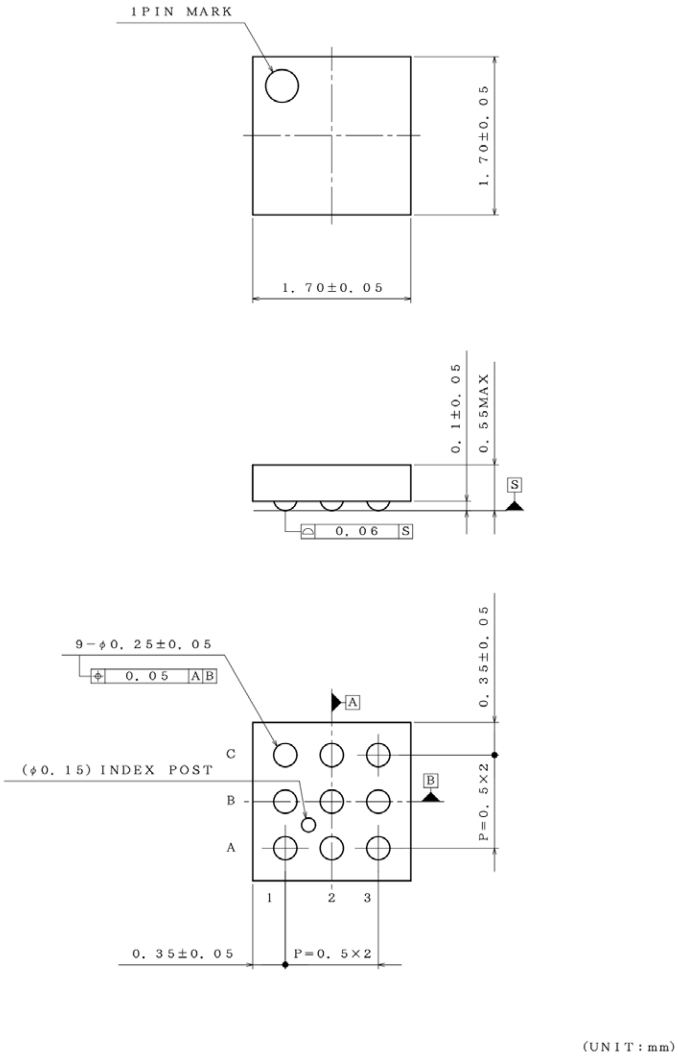
Marking Diagram



Part Number Marking	Package	Orderable Part Number
5469	VCSP50L1	BD5469GUL-E2

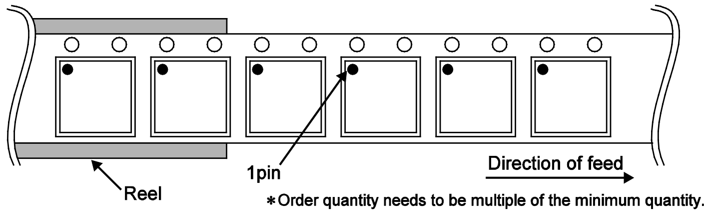
Physical Dimension, Tape and Reel Information

Package Name	VCSP50L1(BD5469GUL)



<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.

Revision History

Date	Revision	Changes
04.Apr.2014	1.0	New Release

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(Note1) Medical Equipment Classification of the Specific Applications

JAPAN	USA	EU	CHINA
CLASSⅢ	CLASSⅢ	CLASSⅡb	CLASSⅢ
CLASSⅣ		CLASSⅢ	

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   [b] Installation of redundant circuits to reduce the impact of single or multiple circuit failure

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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 on a surface-mount products, the flow soldering method must be used on a through hole mount products. If the flow soldering method is preferred on a surface-mount products, 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.

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Since concerned goods might be fallen under listed items of export control prescribed by Foreign exchange and Foreign trade act, please consult with ROHM in case of export.

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